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AUDIOMETRIC STUDIES OF THE RESIDUAL HEARING OF PUPILS OF RIO DE JANEIRO NATIONAL INSTITUTE FOR THE DEAF

I. Auditory Acuity of Deaf Children

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THE STUDY of the auditory acuity of deaf children based on new ideas and methods of otologic research has brought out different and interesting phases which are of scientific and pedagogic interest.

It has given valuable information as to the characteristics of the residual hearing, and it has also suggested many possibilities of greater usefulness of the remnants of hearing.

The problems of deafness—in a secondary position for so many years—are now, in the last two decades, being studied by a large body of specialists; this is to be atributed in great part to new developments of the physics of sound. Increasing interest in this subject is noticed in scientific and clinical investigations. These have within their scope such problems as the recognition of new etiologic factors and the diagnosis, the prevention and, finally, the treatment of diseases of the ear. Adequate methods of instruction, auricular prosthesis and rational therapeutics have been put in practice. All these subjects are closely associated with modern acoustics and the speedy march of today's science.

In the second half of the nineteenth century men from different countries, European physicians, physiologists and aurists, spent a lifetime endeavoring to show the importance of knowledge of the normal and the pathologic physiology of hearing. Their efforts, although they were based on accurate research and experiments of outstanding clinical value, were not always successful in making converts who would pursue the same studies. Of those active during this period, two remarkable scientists should be mentioned. Their meticulous examinations of the residual hearing of deaf children went beyond what might be expected. The work done by Urbantschitsch and Bezold to show the importance of acoustic training of the deaf and the existence of isolated tonal

zones, termed "tone islands," is of immense help to science and to otology in particular. They, together with Helmholtz, have established basic rules for the future development of acoustics and physiology, both applied to the pedagogy of the deaf. Urbantschitsch is credited with new orientation of the acoustic training of deafened adults and deaf children; hence, the extensive use of the acoustic method in some European schools, and the improvement of the therapeutics of certain types of acquired deafness. Scientists who came immediately after, made a few innovations, but the basic principles have remained the same.

Great progress has been made in recent years in the fields of physical and applied acoustics. Noteworthy is the work done by the North Americans, which has enabled otologists to make better experimental studies of deaf children. This fact has contributed much to the keen attention that has been devoted lately to this kind of experimentation. The methods of measurement of hearing, as well as the means of sound transmission and sound amplification, now in use show a higher percentage of children bearing residual hearing. As a result, otologists are at better advantage in pedagogic training and are able to achieve better stimulation of the ear and to employ a more accurate technic in auricular instruction.

With the introduction of audiometry based on experimenttal methods and on the Weber-Fechner psychologic law—the one applied to sensations—it was possible to make more accurate tests of auditory acuity. Many causes of errors associated with the old method were then eliminated. The measuring of the intensity of a tone at the threshold of audibility by the use of the decibel scale has become a scientific process by means of which the hearing capacity can be determined. The audiometric test not only helps one in diagnosing the pathologic condition of the ear but also informs one, in case of auditory loss, as to how accentuated it is. Together with the anamnesis and a careful examination of ear, nose and throat and a vestibular test, it gives valuable information as to the nature and the degree of the hearing impairment.

As shown, the audiometric process plays an important role in the determination of the normal or the pathologic condition of the ear. When it comes to the study of the deaf person's residual hearing, the same may be said. This is on account of a better as well as meticulous examination which that process made possible. When the audiometric characteristics of the hearing loss are recorded, together with the development of that loss, in the audiograms, the records obtained help greatly toward a better understanding of the pathologic condition. Yet, with the audiometric proofs, otologists are going to find signs or well defined phenomena which appear simultaneously with the progressive process of impairment, indications that the pathologic state of hearing is getting worse. Finally, the audiometric process makes possible a qualitative and quantitative study of the residual hearing

and favors a better comparison of the curves representing the hearing by air and bone conduction. This is essential for a good clinical and experimental appreciation of deaf children and for the study and diagnosis of perceptive deafness.

CHARACTERISTICS OF THE RESIDUAL HEARING OF DEAF CHILDREN BY AIR AND BONE CONDUCTION

The study of the residual hearing of deaf children may be conducted either by means of normal acoumetric tests or through the use of the audiometer.

The measurement of hearing by bone conduction becomes as important as that of hearing by air conduction with any of the aforementioned methods, for it is known that the bone conduction is closely related to the mechanism of the sensory organ and to the auditory nerve.

Since the first experiments with children of the Rio de Janeiro Institute for the Deaf, undertaken in 1931 by Henrique Mercaldo, M.D., head of the clinical department—with the use of the instruments he could afford at that time—it was noticed that in the majority of cases hearing by bone conduction was not evident or was only observed at the lower tones of the tuning forks, namely, 128 and 256 double vibrations. At the same time he was having fair results from tests of hearing by air conduction, recording thresholds for frequencies from 512 up to 2048 double vibrations, provided adequate intensities were used. The perception of the tone of the last fork usually occurred with the Galton whistle at the lower limits of its scale. It is worth mentioning that a great number of children heard bells of different tonalities.

In only a few cases was the bone conduction curve as extensive as the air conduction curve while the situation in which the former was longer than the latter was most uncommon.

Although the difference observed was attributed to severe damage of the nerve type, it seemed rather peculiar that air conduction was more preserved than bone conduction; for it was the general understanding that the auditory loss by bone conduction should be followed by the loss by air conduction.

Among the publications of that time one finds references to the use of bone conduction in teaching deaf children.[1] Not only the results of the early acoumetric tests but the results of experiments, as will be shown later, did not agree with that, not in a single case.

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1. Malherbe, A.; Vilenski, R., and Herman, N.: Exposé des recherches entreprises à l'Institution Nationale des Sourds-Muets de Paris: Concernant les reliquats auditifs décelés chez les Sourds-Muets et la possibilité d'entreprendre leur utilisation pedagogique notamment par voie osseuse, Paris, Institution Nationale des Sourds-Muets de Paris, 1935. Guilder, R. P., and Hopkins, L. A.: The Importance of Auditory Function Studies in the Educational Program for the Auditorially Handicapped Child, Volta Rev. **38**:69-70 (Feb.) 1936.

The cases in which we observed bone conduction thresholds long enough to permit pedagogic training were rare. When this happened, equal or better conditions were verified by air conduction.

We started our training, using the spoken voice, without any hearing aids. Later we introduced in our auricular classes the modern amplifiers of sound. With the help of this amplification, the children receive by air conduction the teacher's voice, as well as any other auditory stimuli produced in the class room. And the results of this auricular teaching have been encouraging to the present time. The classes are under the leadership of Sr. J. B. Silvado, who made especial inquiries with regard to the subject during his trip to the United States in 1938.

But, what finally marked a new era in our work was the introduction of the audiometric tests, which have enabled us to make a more accurate analysis of deafness. Using a Western Electric 6 A Audiometer, fully equipped, a Pilling-Witting auditory masker and a soundproof room, we started a new phase of research on the auditory acuity of pupils, studying the problem in a qualitative as well as in a quantitative way.

The hearing of 241 children was examined with respect to both air and bone conduction. There were boys and girls, their ages ranging from 7 to 21 years.

Many of the children gave satisfactory answers which were recorded; the responses of others were not reliable. In the first group we find those who acquired the impairment after birth and also those who were born deaf but had some residual hearing and thus were able to recognize the acoustic impressions. In the second group, besides the children whose impairment could be attributed to a psychologic disturbance, there were children who, on account of a marked degree of impairment, had poor conception of sound. The audiograms of these children, as well as those of the younger ones, were taken into consideration only after they had been through a training program which enabled them to recognize the sound so that their answers might be regarded as reliable.

The children who after that did not give reliable responses to the audiometric tests were eliminated. Their records have therefore been excluded from further consideration in this study. With those records excluded, the total material which serves as a basis for this analysis is composed of 200 audiograms. The difficulty in questioning the subjects increased with decreasing age, so that it became impossible to record the answers of the ones less than 7 years.

The audiometric tests, being more accurate, enabled us to make a far better comparative study between air and bone conduction. The 379 curves obtained for hearing by air conduction against the 233 for hearing by bone conduction are in themselves a notable proof of the

better perception with the former. The air conduction curves have also a wider range, which was a result of the greater number of auditory perceptions. This is important from the pedagogic standpoint, since it is considered in choosing the hearing aids that are to be utilized in the auricular classes. On the other hand, the bone conduction, giving better information of the cochlear function, is useful in arriving at the diagnosis and the prognosis of deaf-mutism. It is opportune to emphasize here that there was not observed any discrepancy between the audiometric records of hearing by bone and by air conduction related to the sexes.

Only in 5 audiograms, that is, 2.5 per cent, was no mark registered at any frequency of the audiometric range either for bone or for air conduction, these audiograms indicating total loss of serviceable hearing. In all the cases in which a total loss of hearing by air conduction was observed the tests of hearing by bone conduction gave negative results. On the other hand, there was not a single case in which bone conduction was picked up alone. The very reduced number of those who did not experience any sensation with the auditory stimuli draws one's attention.

The following statistical data on the threshold values of hearing by bone and air conduction of our children give a clear picture of the type of auditory loss. They present some deviations from the ones published in the ARCHIVES OF OTOLARYNGOLOGY by Walter Hughson, Antonio Ciocco and Carol Palmer in their "Studies of Pupils of the Pennsylvania School for the Deaf." [2] The main difference lies in the fact that our median auditory threshold curves for air conduction were wider and our median curves for bone conduction shorter. Yet, using a different procedure, we separated the results of each ear for better comparison of the thresholds of hearing by bone and air conduction.

We have utilized the same statistical constants. The first quartile expresses the auditory threshold of 25 per cent of the ears which heard best; the median expresses the auditory threshold of 50 per cent of the ears with the best hearing. If the first quartile is omitted (indicated by a dash), it means that less than 25 per cent of the ears were able to hear the tone. In a similar manner, if a median is omitted, it means that less than 50 per cent of the ears were able to perceive the tone at the greatest intensity possible to the audiometer. From the data obtained for every audiometric frequency, tables and charts were constructed for residual hearing by bone and by air conduction. The first quartile and median auditory thresholds of the right and the left ears of those children are shown in charts 1 and 2.

2. Hughson, W.; Ciocco, A., and Palmer, C.: Studies of Pupils of the Pennsylvania School for the Deaf: Auditory Acuity, Arch. Otolaryng. **29**:403-416 (March) **1939.**

Frequencies 256 and 512 were the only ones heard by 25 per cent of the children by bone conduction; on the other hand, all the tones of the audiometric range but the one of 8,192 cycles were perceived by 25 per cent or more by air conduction, as shown in table 1. Similarly, as shown in table 2, frequencies from 128 to 4096 and 8192 were heard

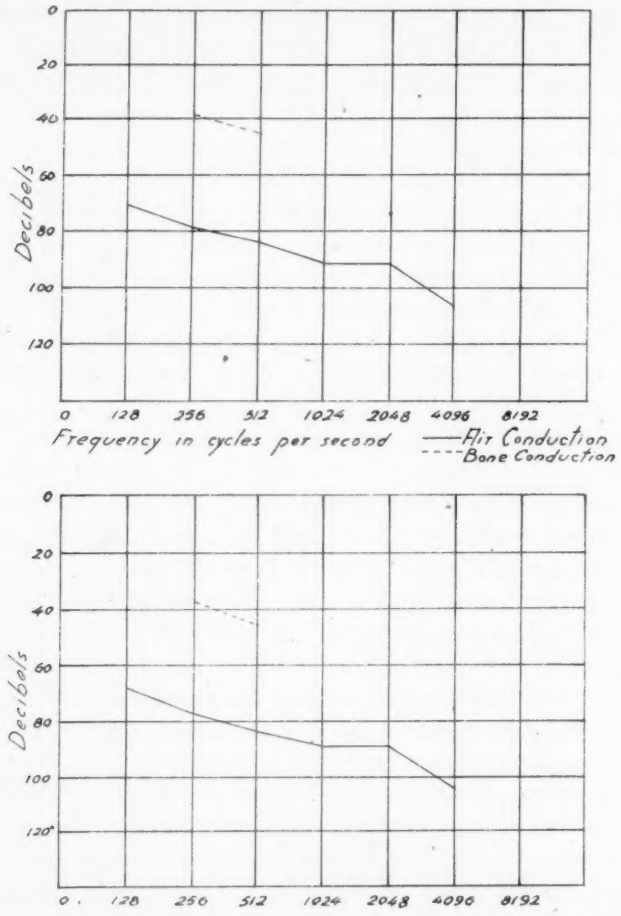

Chart 1.—The first quartile threshold curves for the right and the left ears of deaf children who had residual hearing of air-conducted and bone-conducted frequencies. Upper part, right ears; lower part, left ears.

by less than 50 per cent by air conduction, while the cycles 256 and 512 were the only ones that 50 per cent or more discerned by bone conduction.

Examining the first quartile and the median auditory thresholds, one notices that the auditory loss is about the same in the right and the left ears, by air or by bone conduction. An exception is made of the median for air conduction of the right ears; a more pronounced depression is seen at 1024 cycles.

One notices that the first quartile thresholds by air conduction, the data on which are arranged from the better to the worse ears, have a wider frequency range and are situated at more convenient levels than the median, as illustrated by charts 1 and 2. The latter shows better the general aspect, the curve for air conduction thresholds being

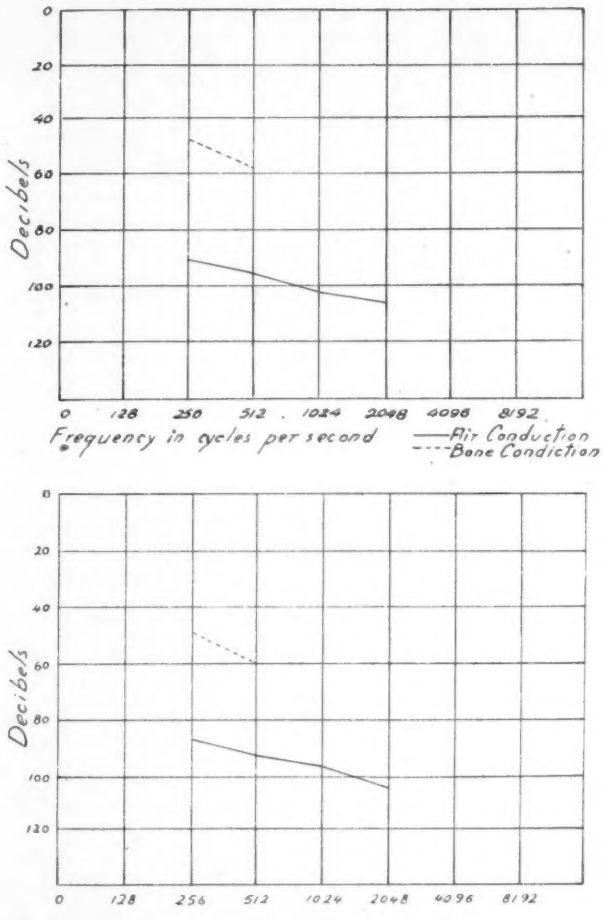

Chart 2.—The median threshold curves for the right and the left ears of deaf children who had residual hearing of air-conducted and bone-conducted frequencies. Upper part, right ears; lower part, left ears.

less wide, and that for bone conduction thresholds as wide as the one of the first quartile but at higher levels than the latter. This is an indication that the marks, or thresholds, are concentrated at higher intensities mainly by bone conduction. Besides, it may be noted that the air conduction curve of the first quartile covers a range of frequencies from 128 to 4096 cycles, and that the curve of the median thresholds

goes only from 256 to 2048 cycles. The bone conduction curve extends from 256 to 512 cycles, whether of the first quartile or of the median, though at different levels.

The purpose of table 3 and chart 3 is to make possible a better study of the children's hearing by air and by bone conduction, in both ears. The whole picture of all the individual observations made over the frequency range is shown, including the ones that were excluded from the first quartile and the median. In chart 3 the difference between the air and bone conduction curves shows up better. Noteworthy is

TABLE 1.—*The First Quartile for the Right and the Left Ears of Deafened Children Who Had Residual Hearing of Air-Conducted and Bone-Conducted Frequencies*

Frequency in Cycles per Second	Right Ear		Left Ear	
	Air Conduction	Bone Conduction	Air Conduction	Bone Conduction
128	71.36	—	67.78	—
256	78.67	38.95	77.94	38.33
512	83.75	45.45	83.00	46.00
1024	91.04	—	89.47	—
2048	91.25	—	89.44	—
4096	106.25	—	104.33	—
8192	—	—	—	—

TABLE 2.—*The Median for the Right and the Left Ears of Deafened Children Who Had Residual Hearing of Air-Conducted and Bone-Conducted Frequencies*

Frequency in Cycles per Second	Right Ear		Left Ear	
	Air Conduction	Bone Conduction	Air Conduction	Bone Conduction
128	—	—	—	—
256	88.88	49.37	87.42	49.08
512	94.10	59.17	93.30	59.75
1024	101.19	—	95.88	—
2048	105.28	—	105.34	—
4096	—	—	—	—
8192	—	—	—	—

the small number of observations at 128 cycles, as well as the abrupt change starting at 2048 cycles by air conduction and at 512 cycles by bone conduction. This shows that the tones were not perceived by most of the children at the maximum intensity.

In all the diagrams one notices a general tendency for the disappearance of perception, or an abrupt change in the curves, at the lowest tone and at the higher ones, which is more pronounced in the charts for general measurements. Bone conduction curves shorter than air conduction curves are also noticed.

These results from the analysis of the children's residual hearing reveal the presence of nerve, or perceptive, deafness, as described by so many different authors.

The curves shown characterize better this type of deafness because they are based on audiometric tests of deaf children, in whom an advanced stage of the pathologic process is responsible for the perceptive deafness. This type of auditory loss is a consequence of degenerative or atrophic lesions of the nerve and the sensory organ, or only of

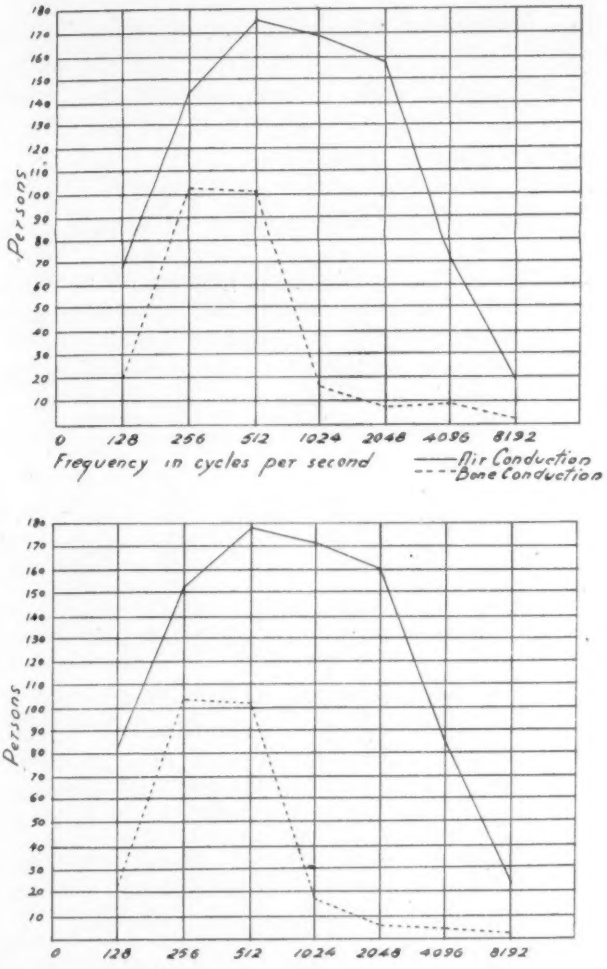

Chart 3.—Comparative curves of the numbers of children with residual hearing of air-conducted and bone-conducted frequencies. Upper part, right ear; lower part, left ear.

the latter. These injuries, the cause of profound deafness, may have originated as congenital lesions or may have been acquired in the first years of life.

Of the 200 children for whom there is a report of the age of onset of the impairment, 70 per cent were said to have been born deaf; there-

fore, they had congenital or constitutional lesions. Syphilis (36 per cent), hereditary deaf-mutism (7.5 per cent) and alcoholism (3 per cent) were most frequently stated to have been the causes of the deafness. The cause was regarded as obscure in 23.5 per cent of the children.

The percentage of those who acquired the impairment after birth is about 30 per cent.

The differences between the children's audiograms of the two groups are not regarded as significant. This strengthens the suggestion made by the North American authors "that the pathologic mechanism has been the same in children who suffered marked loss of hearing as in the ones with a congenital defect."

However, Fischer and Wolfson [3] are inclined to accept that "deafness with eventual remnants of hearing (tone islands), associated with

TABLE 3.—*Numbers of Cases of Deafness in Which Auditory Thresholds Were Established for Air-Conducted and Bone-Conducted Frequencies*

Frequency in Cycles per Second	Right Ear: Number of Cases				Left Ear: Number of Cases			
	Air Conduction		Bone Conduction		Air Conduction		Bone Conduction	
	No.	%	No.	%	No.	%	No.	%
128	67	8.32	20	7.66	82	9.58	22	8.53
256	145	18.01	103	39.47	153	17.87	104	40.32
512	176	21.87	102	39.08	178	20.80	101	39.11
1024	169	20.99	16	6.13	171	19.98	17	6.60
2048	158	19.63	8	3.07	160	18.69	6	2.33
4096	71	8.82	9	3.45	88	10.28	5	1.94
8192	19	2.36	3	1.14	24	2.80	3	1.17
Total	805	100.00	261	100.00	856	100.00	258	100.00

normal labyrinthine function, points rather to the heredo-degenerative type. A condition in which there is a complete loss of hearing and of labyrinthine function favors more the diagnosis of acquired deaf-mutism."

Among the 59 children who presumably acquired their difficulty of hearing after birth, the disease most frequently stated to have been the cause of the deafness was injury of the head (7 per cent). Next in order came the different forms of meningitis (5 per cent), measles (4 per cent) and epidemic cerebrospinal meningitis (3 per cent). With less frequency, the stated causes include diphtheria (1.5 per cent), malaria (1 per cent), pneumonia (1 per cent), paratyphoid fever (1 per cent), scarlet fever, typhoid, infantile paralysis and obstetric traumatism, which occurred in single cases. The cause was regarded as obscure in 4 per cent of the children.

We failed to establish any correlation between the etiologic factors and the audiometric curves. At first, we thought that more extensive

3. Fischer, J., and Wolfson, L. E.: The Inner Ear, New York, Grune & Stratton, Inc., 1943, p. 317.

curves for bone and air conduction were associated with syphilis, and the less extensive, with epidemic cerebrospinal meningitis. Later it was verified that these diseases presented other types of audiograms, also. On the other hand, the curves aforementioned were connected with other diseases. No audiogram was obtained that could be said to be characteristic of a certain etiologic factor. We agree with the North American authors when they say that "there is apparently no association between auditory thresholds and stated causes of deafness." It is the opinion of some authors that no relation can be found between the thresholds and the lesions situated in the cochlea and in the auditory nerve.

That has been the opinion of Bing [4] : "It is rather difficult to establish in any human being a clearcut demarcation between the deafness due to damage of the sensory epithelium and that caused when the auditory nerve is injured." His explanation was: "If the peripheral endings of the nerve are more influenced by infectious or traumatic processes, on the other hand, there are certain morbid causes such as tuberculosis, syphilis and scarlet fever, which can cause either labyrinthitis or neuritis." He proceeded: "The acoumetric method used in the diagnosis of nerve deafness, unfortunately does not give accurate knowledge of the location of the pathologic process in the perceptive apparatus: organ of Corti, auditory nerve, nucleus or cortical fibers."

However, Crowe [5] mentioned two practical applications of histologic study in cases of nerve deafness.

". . . When the loss of hearing begins at 256 or 512 vibrations and increases gradually toward the higher tones, the lesion is atrophy of the cochlear nerve supplying the basal turn of the cochlea, and the organ of Corti is not affected. When the audiogram shows an abrupt or sharply localized impairment of perception for high tones, both the nerve and the organ of Corti in the basal coil are atrophic."

For an accurate determination of the etiologic factors and the pathogenic diagnosis of nerve deafness, we have to make use of other factors given by anamnesis, the state of the pathologic process and the clinical symptoms. Those data can be obtained from deafened adults. But, when one is dealing with a deaf-mute child, such material is hard to obtain, since in most of the cases the deafness is due to congenital and hereditary factors or has an obscure cause. Sometimes, with children who presumably acquired deafness after birth, a case history may be given, but we cannot trust it for a precise diagnosis.

4. Bing, R., and Curchod, E.: Diagnostic topographique des lésions de l'encéphale et de la moelle épinière: Précis de localisations clinique des affections et traumatismes des centres nerveux, Paris, G. Doin, 1921, pp. 140-141.

5. Crowe, cited by Shambaugh, G. E.: Chronic Progressive Deafness, Including Otosclerosis and Diseases of the Inner Ear, Arch. Otolaryng. **30**:999-1036 (Dec.) 1939.

In practice the audiometric tests, as well as the other acoumetric tests, did not help much in locating the lesion in cases of nerve deafness. The same cannot be said concerning the conductive impairment, in locating a lesion in the middle ear or in differentiating it from a lesion of the nerve in the inner ear.

According to Stevens and Davis [6]

". . . the damage of the sensorial cells, nerve fibers and nerve centers, immediately connected with them, produces what has been variously designated as nerve deafness or perception deafness. Nerve deafness is not always due to the degeneration of the auditory nerve, but may result from degeneration of the hair-cells of the organ of Corti. Damage to the hair-cells is, however, physiogically equivalent to damage to the nerve."

Finally, the audiometric curves of these cases give the reader an idea of the functional disturbance due to the perceptive or nerve type of deafness. It is generally associated with the pathologic mechanisms resulting from the atrophic or degenerative lesions of the auditory nerve or sensory organs, and yet it is a process involving them.

"VANISHING PERCEPTION" OF AUDIOMETRIC TONES AND THEIR RELATION TO AUDITORY FATIGUE

The results at which we have arrived when dealing with the residual hearing characteristics of deaf children go much farther than has been shown so far.

The tests of the auditory acuity of deaf children made with the audiometer, which were carefully conducted, owing to the interest we had in establishing a quantitative and a qualitative relation between the hearing by bone and that by air conduction, guided us to the verification of some other facts of the utmost importance.

The test of bone conduction, because of the relation of the latter to the inner auditory mechanism and, moreover, because of the interesting results we were obtaining, attracted our attention from the very first experiments. This increasing interest contributed much to our establishing some essential features by study of our own observations.

Adding the facts already noted and the ones we shall present, we may divide the results of the audiometric tests of the hearing by bone conduction of deaf children into three main classes:

1. Those which could not be registered on the audiograms.

2. Those which were recorded at some frequencies, mainly 256 and 512.

3. Those which showed perception but of such a slight and transitory nature that recording was impossible.

6. Stevens, S. S., and Davis, H.: Hearing: Its Psychology and Physiology, New York, John Wiley & Sons, Inc., 1938, p. 288.

The results in classes 1 and 2 have been studied. Now we shall take the last class, which from the experimental standpoint is by far the most important. We shall first analyze the facts which led us to the conclusion that there was a very rapid auditory perception, and then go over the progressiveness of the impairment of the hearing of our patients, according to the consecutive tests they underwent.

From the beginning of our experiments we noticed how difficult it was in some cases to record frequencies which were heard in a peculiar way, too quickly and too inconstantly, though doubtless hearing was present. As the examinations continued, it was possible for us to make a careful and meticulous analysis of this fact, which was in complete disagreement with what was usually noticed in the study of the threshold of audibility. Because of its strange evanescent behavior, we decided to name this very special auditory phenomenon "vanishing perception" of the audiometric tone.

The first thing that strikes one's attention when facing phenomena of such a nature is the difficulty or rather the impossibility of recording auditory thresholds at the higher levels of intensity, contrary to what usually happens when the patient perceives any type of frequency. It is so rapid that we have failed to record it, though we have tried hard. Some of the children have reported that the sound first heard vanished, and others have the impression that the sound was suddenly interrupted.

This phenomenon observed in testing bone conduction also occurs with air conduction, though not so often. It has been noticed by air conduction in cases in which there was a marked degree of impairment and in which the auditory thresholds of other frequencies, if existent, were situated at higher levels of intensity (as shown in chart 4).

There are usually registered, for every frequency of the audiometric range, thresholds from the lower levels to the upper levels of intensity both by air and by bone conduction. The extreme marks are often observed in the bone conduction curves on deaf children's audiograms, where it is noticed that the thresholds are concentrated at or around the upper levels of intensity of bone conduction and at the frequencies 256 and 512, as shown by their auditory "median" (chart 2).

However, as to the "vanishing perception," we verified the impossibility of its being recorded at those upper levels of intensity where it is perceived, not to speak of the lower levels where it is not even observed. It is noticed only at the extreme level or at two or three levels situated right below this, and when we try to record this auditory sensation, the children have no response to it no matter how high the intensity is, contrary to what is commonly observed at the auditory threshold of a tone. This "transitory perception" lasts for a few seconds and is followed by a period of silence varying from one to three minutes

or even more. Its reappearance occurs at the same levels and in the same fashion. After a variable but small number of manifestations, and sometimes after its first appearance, it is perceived no more. This is the reason why the frequency which was heard evanescently fails to be perceived immediately afterward, even with the maximum intensity being used, but is heard within some minutes, after a new trial. This process goes on a few times till the patient has no more perception.

To the evanescent characteristic—the most important one—we can add the inconstancy; that is, the frequency is not always perceived at the same level and after the same interval of time.

Thus proceeding, we may summarize the main features of the "vanishing perception" of audiometric tones as follows:

(*a*) The hearing of audiometric tones by bone or by air conduction at high intensity levels is of short duration.

(*b*) The sensation lasts a few seconds; a silent interval succeeds each of its appearances till there are no more responses.

(*c*) It displays inconstancy or variability.

(*d*) Recording it is an impossibility.

Another fact that drew our attention was its special preference for certain frequencies.

In the tests of bone conduction, as soon as the receiver is placed against the mastoid process an interesting phenomenon commonly occurs. Let us take a low and a high frequency, say, 128 and 1024, where a rapid perception is noticed twice or three times. If we now move over to the frequencies 256 and 512 perception of these can be recorded, while at the higher frequencies (2048) no auditory sensation is heard. This phenomenon is observed till the end of the experiment, that is, when no more perception is verified at 128 and 1024 cycles. These different results with the same persons and with the same tests reveal a different phenomenon, provided we have used a rigorous and consistent technic.

To observe the evanescent perception we employ different procedures—all leading to the same objective. To begin with, after placing the bone conduction receiver against the patient's mastoid process, we start the test with the usual technic, trying to keep as reference the intensity level corresponding to the threshold of the tone under test. As soon as a very quick perception is noticed and the difficulty of recording it is at the same time verified, we try to raise the intensity to its maximum, in order to make sure that the tone is not heard at this level. This will be the indication that the "evanescent phenomenon" has occurred. Lowering the dial 10 to 15 decibels from the point where the phenomenon was originally heard, then moving it quickly upward so as to go over the same spot, till it reaches the maximum intensity, there can be observed a perception, essentially evanescent, as

if it were a spark of the audition which emerged, dimming out at that limit.

Another way of searching for the "vanishing perception" consists in maintaining the maximum intensity from the beginning; now it may happen that the patient hears the tone used in the test, and will suddenly fail to perceive it. If we go back looking for the same frequency at the maximum intensity a few seconds later, there is a possibility of its being distinguished in the fashion already described, that is, evanescently, while the audiometric tones of the neighborhood, and even those farther apart, are perceived differently. In order to obtain this effect easily, the following technic is advisable: We place the intensity dial at its maximum and, interrupting the sound, we abruptly change from one frequency that can be recorded, into that in which the "vanishing perception" has occurred, noticing then that it reappears as soon as the switch is on. It is advisable to go over the frequency range, and then go back to the point where the "fleeting manifestation" was heard, in order to get confirmation. With some skill and patience, it is possible by means of successive maneuvers to verify the intermittency of the sensation and also to determine how often it is observed during a test.

We might have made mistakes which would lead us to false conclusions. To avoid that, we have conducted our experiments carefully, being aware of any little thing. The first of them, the most elementary one, would be the misplacing of the bone conduction receiver. This was checked in every trial. A second cause of error, also due to the recorder, was to take a threshold at the maximum level of intensity as the "vanishing perception"; careful analysis, followed by a good technic, showed us that the perception at the "extreme threshold" is more clear when one is using the tone switch which makes possible its recording, while the "vanishing perception" is not influenced by this. As was to be expected, some of our children would not give reliable responses to some of the tests. To avoid such a cause of error, their tests were excluded from further consideration in this study. Besides, not only with the children but also with deafened "grown-ups" having severe cochlear or nerve impairment we had the opportunity to test this same "evanescent perception." The answers of the latter may be regarded as absolutely correct, removing then all doubts, if any existed.

The last, but not the least, cause of error was to take a tactile sensation, though fugitive, as an acoustic one, for we accept the fact that auditory fatigue favors tactile interference. In a profoundly deafened person who is being tested by bone conduction, the vibration of a low tone fork may cause a tactile sensation, and this may be understood as an auditory one. Would it not be right to assume that the bone conduction receiver of the audiometer could act in the same manner?

Similar questions were asked by Hughson, Ciocco and Palmer[7] in their report of the results of studies by bone conduction in a group of children: "Was it in every instance true perception by bone conduction, or at the high intensities of the lower frequencies was it purely tactile?" To these questions they answer: "Experience with the particular bone conduction receiver used indicates definitely that at the maximum intensity of the frequencies 128, 256 and 512 cycles there is a definite tactile factor. However, the averages shown in the following tables are below this maximum intensity, and at the particular values for 512 cycles the tactile factor of the receiver is negligible. If, therefore, there is a response to the frequency, 512 cycles, it seems justified to assume that bone conduction is present." Those conclusions may be extended to the "vanishing perception," because it is an auditory sensation, though it last seconds.

Those authors admit that the tactile factor originates at the maximum intensity, and at the particular frequencies, say, 128, 256 and 512, at which the "vanishing perception" also appears. This might have created a serious objection to the observed facts if we had not noticed that during the experiments this perception was more frequent at 512 cycles, and at higher tones, while the former was more observed at the lower frequencies. To stress that, we may state that in 216 tests made by bone conduction, either in one or both ears, and at the different frequencies, the "vanishing perception" appeared fifty-two times at 1024 cycles, forty-six times at 512 cycles, forty times at 256 cycles, thirty-four times at 2048 cycles, twenty-three times at 128 cycles, eighteen times at 4096 and only three times at 8192 cycles. The great majority was heard at 1024 cycles and 512 cycles, frequencies with which the tactile factor was nihil or negligible. At 1024 cycles and at the higher frequencies the total percentage of the manifestations goes as high as 49.6, while at the lower frequencies it stays at 29.1, thus decreasing at the lower tones, with which the tactile factor is stronger. This is an element of the utmost importance when one seeks to define the perception of an acoustic sensation.

There is yet another circumstance which helps in differentiating the tactile factor from the "vanishing perception." In the test of the cranial perception, only the forks lower than the C (128 double vibrations) "gave a tactile sensation that could be interpreted as an auditory sensation" (Heiman[8]). As the lowest tone given by the Western Electric Audiometer corresponds to 128 double vibrations, a question comes to our mind: Does the tactile phenomenon occur at the maximum intensity with this frequency, as well as with 256 cycles? This may

7. Hughson, Ciocco and Palmer,[2] p. 412.

8. Heiman, T.: L'oreille et ses maladies, Paris, G. Steinheil, 1914, vol. 1, p. 365.

be followed by another: May not this factor, described by the authors as tactile, be a manifestation of the bone, that is, a vibratory sensation due to the superficiality of the mastoid process, and thus interpreted as an auditory sensation?

The sensation, whether tactile or vibratory, which can be mixed up with the auditory one is of a steadier and longer duration, finishing simultaneously with the molecular vibrations of its source. Instead, the "vanishing perception," besides being an auditory sensation, is an intermittent phenomenon, of short duration, and can be verified at a certain moment of the sound vibration.

In order to find out whether the children were able to distinguish the auditory sensation by bone conduction from the tactile and vibratory ones, several experiments were made at the frequencies 128, 256 and 512, when tones could be perceived by bone and air conduction, or at least by the latter, at the higher intensities. Placing the bone conduction receiver, the intensity being kept constant, now on the palm or the finger tips, then against the child's mastoid process, and using the air receiver for comparison, we found that they were able to differentiate the sensations under test. Even if we admit that this factor is not exclusively tactile or superficial, because of the close proximity to the skeleton in this region (though much less close than the mastoid process) the important fact to us is that the children having some residual auditory perception were able to make a distinction between this strange factor and the auditory sensation. The results of those experiments have shown it to be possible for deaf children to distinguish an acoustic impression, though evanescent, from any other short sensation, and thus once more our point is stressed that the evanescent perception is an auditory phenomenon.

Urbantschitsch [9] and recently Douglas Macfarlan [10] have conducted researches in which they showed the possibility of differentiating tactile from auditory impressions in deaf children.

The younger pupils and the profoundly deaf ones went through a training period with the audiometer, in order to get used to the acoustic impressions, till they became able to distinguish these sensations from any others that could appear during the test.

Testing some children with such a severe hearing loss that it was almost impossible to record it, we had the opportunity of observing the same evanescent phenomenon by air conduction, though not so often, but

9. Urbantschitsch, V.: Des exercices acoustiques dans la surdi-mutité et dans la surdite acquise, translated by L. Egger, Paris, A. Maloine, 1897, pp. 79-81.

10. Macfarlan, D.: Distinguishing Between Tactile Sense and Audition in the Deaf Child, Arch. Otolaryng. **5**:507-508 (June) 1927; Tactile Sensation as Related to Hearing Testing and Hearing Impressions Through Nerves Other than the Eighth, Ann. Otol., Rhin. & Laryng. **42**:680-689 (Sept.) 1933.

by all means similar to the one by bone conduction. This fact was plainly confirmed by the successive experiments. Like the vanishing perception by bone conduction, it always appeared at the higher levels of intensity and yet, because of its fugacity and intermittency, the recording of it was impossible.

In the cases in which the "vanishing perception" of an air-conducted frequency was observed, we found severe loss of hearing not only by bone but by air conduction, and the marks of the latter when recorded were scant and situated at the limit of the curve indicative of total loss of serviceable hearing. Chart 4 shows a good example of that; hearing by air conduction was recorded only at two frequencies around the curve aforementioned. Here the evanescent perception of

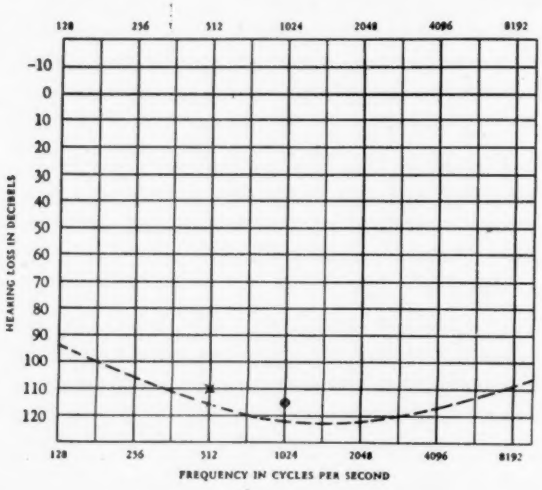

Chart 4.—Audiogram of a case in which the vanishing perception was noticed by air conduction. The threshold of hearing recorded for the left ear is indicated by a cross; that for the right ear, by a circle.

air-conducted sound was observed at frequencies 256 and 512 in the right ear, besides the audiogram's marks (512 left ear and 1024 right ear).

We have observed the "vanishing perception" not only with children but also with adults having marked impairment of cochlear or nerve function—here less frequently. A typical case is one in which a 25 year old man suddenly lost hearing as a consequence of an acute disease of obscure cause with cerebral symptoms that produced a lesion of the auditory nerve. This patient, who had normal hearing before the infection, lost it almost completely, within six days, and when he was examined by us six months later, his failure to perceive the voice was total. He heard only the vibrations of forks C and C_1 when these were placed against his mastoid process, and even these vibrations not

so well, and for a short time. The patient had some subjective symptoms, such as dizziness, which usually appeared at night, but the vestibular tests gave negative results and the Romberg sign was not present. On making an audiometric test we noticed his extreme auditory loss; he was able to distinguish in the right ear, though in an intermittent and evanescent way, the frequencies 128, 256 and 512 by air conduction; he distinguished 256 in the left ear and 512 in the right ear by bone conduction.

"Vanishing perception" of air-conducted tone seems to show, in all the cases, that the degenerative process of the cochlea and the nerve accounting for this type of deafness has reached its final phase; thus "vanishing perception" appears at the same time as almost total loss of hearing, as shown in the audiograms.

INTERPRETATION AND STATISTICS

"Vanishing perception" may be looked on as an audiometric sign of a nerve lesion of the inner ear which is observed in persons with advanced deafness of the perceptive type, particularly in deaf-mutes. This phenomenon was more often recorded in tests of bone conduction.

According to Jones and Knudsen,[11] bone conduction furnishes a direct test of the cochlea; this is particularly true for frequencies above 2000 cycles. It is generally accepted that bone conduction is more related to the cochlea and the auditory nerve than is air conduction. Thus a decrease or a disappearance of hearing by bone conduction is a sign of impairment of the cochlea or of the auditory nerve, as we observed with children, and represents a serious disturbance of the perceptive apparatus.

The "evanescent perception"—accompanied by the impossibility of registering the audiometric tone—found mainly by tests of bone conduction, must be regarded as a symptom of greater damage of nerve elements of the ear and can be used in the diagnosis of this.

There are 200 audiograms of the total number of children tested with satisfactory results, and they show that this phenomenon was observed in 39 per cent of the children by bone conduction, in 4.5 per cent by air conduction and in 4 per cent by both air and bone conduction and that 52.5 per cent gave no responses of the evanescent type. It was noticed by air and bone conduction at one frequency at least and in one of the ears in 47.5 per cent of the audiograms, that is, in almost 50 per cent of the children under test, a fact giving clear evidence of the extreme importance of the phenomenon whether looked at from the scientific or from the statistical point of view. Of all of the cases

11. Jones, I. H., and Knudsen, V. O.: Audiometry and the Prescribing of Hearing Aids: Studies of the Eighth Nerve, St. Louis, The Laryngoscope Press, 1937, pp. 162 and 163.

in which this sensation was verified the perception was by bone conduction in 82.1 per cent, by air conduction in 9.5 per cent and by both air and bone conduction in 8.4 per cent.

Table 4 and the curves of chart 5 show the distribution of cases in which perception was obtained evanescently in air and bone conduction tests throughout the frequency range. The data were obtained not only from the first audiometric tests but from the later ones, made in order to obtain this evanescent phenomenon over and over again.

TABLE 4.—*Frequencies and Cases in Which the Vanishing Perception Was Noticed in Bone and in Air Conduction Tests*

Frequency in Cycles per Second	Number of Cases			
	Air Conduction		Bone Conduction	
	No.	%	No.	%
128	6	13.96	29	8.77
256	7	16.28	67	20.25
512	7	16.28	83	25.08
1024	9	20.94	74	22.37
2048	5	11.62	49	14.81
4096	8	18.60	25	7.51
8192	1	2.32	4	1.21
Total	43	100.00	331	100.00

TABLE 5.—*Frequencies and Cases in Which the Vanishing Perception Verified in the First Audiometric Experiments Was Noticed in Later Verifying Experiments*

Frequency in Cycles per Second	Number of Cases			
	First Proofs		Later Proofs	
	No.	%	No.	%
128	23	10.65	6	5.22
256	40	18.52	27	23.42
512	46	21.29	37	32.17
1024	52	24.08	22	19.13
2048	34	15.74	15	13.04
4096	18	8.33	7	6.09
8192	3	1.39	1	0.87
Total	216	100.00	115	100.00

The curve of cases in which the perception was obtained by bone conduction is smoother because of the greater number of observations taken.

The statistics show that this phenomenon appeared by bone conduction three hundred and thirty-one times and by air conduction forty-three times at different frequencies, in one of the ears at a time, or in both, when this was the case.

Of the three hundred and thirty-one times that it was observed by bone conduction, two hundred and sixteen were verified in the first tests, and one hundred and fifteen in the later ones, as shown by table

5 and chart 6. In the early experiments the vanishing phenomenon was noticed more frequently at 1024 cycles, at which scanty marks or thresholds, were recorded. In the following tests it was observed much more at 256 and 512 cycles, occurring at the same time as the disappearance of the thresholds which were recorded in greater number in the early tests.

The early experiments presented two different types of results: the thresholds which were recorded (charts 1, 2 and 3) and those

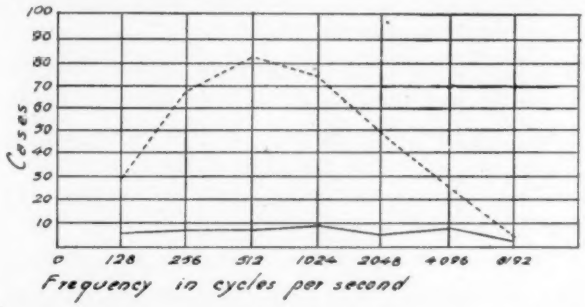

Chart 5.—Comparative curves showing number of cases in which vanishing perception was noticed by bone and by air conduction. Bone conduction is represented by a broken line; air conduction, by an unbroken line.

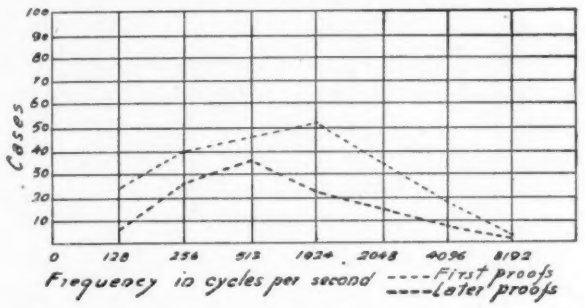

Chart 6.—Comparative curves showing numbers of cases in which the vanishing perception was noticed by bone conduction, in the first and the later verifying experiments.

which were observed evanescently—the first signs of the "vanishing perception" (chart 6).

The evanescent sensation appeared twenty-three times by air conduction in the first tests and twenty times in the later ones. The phenomenon was observed, these twenty times, at the frequencies whose original marks had disappeared.

To summarize, the "vanishing perception" appears much less at frequencies at which it was previously observed than at the new ones.

this being followed by the impossibility of obtaining the original marks. Among the one hundred and fifteen times that the evanescent perception of bone-conducted frequencies reappeared, sixty-one times it reappeared at different frequencies; only the remainder were as found in the original audiograms and at the original numbers of cycles.

It is not within the scope of this paper to analyze the mechanism of this phenomenon, but only to record its characteristics; later on, more accurate and well conducted research might bring out new facts which would confirm or modify those which we have already established, allowing them to be better interpreted.

The explanation of some new matters and the relation between the disappearance of the recordings when the "vanishing perception" was noticed led us to explain in a general fashion those successive manifestations that are related to the progress of the children's impairment. On account of that, we devote more attention to the subject. We shall describe briefly auditory fatigue and its relations, taking up afterward the study of the mechanism and of the "evanescent perception" and trying to explain it in a reasonable manner.

Auditory fatigue, as we know, can be observed either in normal or in pathologic conditions. The auditory fatigue observed under pathologic conditions was described by a few authors as due to an impairment of the auditory nerve. But this phenomenon under this circumstance was better studied by Urbantschitsch.[12] The characteristics of the acoustic *épuisement* (exhaustion) that he described have something in common with those of the "vanishing perception," more than any other factor connected with pathologic auditory fatigue. This author refers to auditory fluctuations and to tones which, normally heard by deaf persons, failed to be perceived seconds after, no matter how strong the intensity. He goes further, mentioning the case of a deaf-mute who after a few seconds fails to hear the tones of an accordion. Is there any relation between this phenomenon and the "evanescent perception"? Is it possible that the progress of science and the new technic have helped one to observe and measure better the same acoustic phenomenon, adding to it some new features?

It would have been possible for this remarkable man of science to observe a similar occurrence, though the instrumental condition was poor. But it is opportune to remember that he used in his experiments the spoken voice and the sound of the accordion, which can easily cause auditory fatigue. Conversely, the "vanishing perception" was obtained by bone and air conduction tests made with an accurate instrument—the audiometer—which produces pure tones with established frequencies.

12. Urbantschitsch,[9] pp. 75-79.

Recently experiments have been carried out by different authors in the study of physiologic fatigue. It has been thoroughly established that all normal ears fatigue when exposed to sounds of high intensity.

Under normal conditions auditory fatigue is a physiologic phenomenon, in the production of which cortical factors partake and play an important role.[13]

We might therefore say that the "transitory perception" observed at high levels of intensity in cases of marked auditory loss is a sensorial or peripheral phenomenon closely related to the pathologic condition of the nerve elements of the ear, and found only in such cases. It would thus be regarded as a form of fatigue, essentially sensorial and connected with the degeneration of the nerve elements of the ear.

Since it is known that the auditory nerve and the cochlea when damaged easily fatigue, a reasonable explanation of the "vanishing perception" might be that of a greater tendency of the nerve endings of the organ of Corti or of the nerve fibers to become exhausted. This is due to severe anatomic changes which obstruct the nerve and cochlear function, making any response to auditory stimuli almost impossible. So, to the maximum degree of the lesion of the auditory nerve would correspond the maximum fatigue produced by audiometric tones when these are at high levels of intensity.

Now, a question comes up which is of utmost importance in the understanding of the evanescent phenomenon. Does the production of this phenomenon at a high level of intensity depend on the mechanism accounting for the fatigue or is the intensity alone able to produce this transitory sensation, regarded as the last vestige of auditory function before its final disappearance? Is it possible that this state of auditory loss favors fatigue? In this last hypothesis, the evanescent sensation would be attributed more to degeneration of the nerve elements of the ear than to auditory fatigue.

The "vanishing perception," so closely related to poor functioning of the cochlea and the auditory nerve, would mean in its essence the degeneration of auditory nerve elements. The point we want to stress is: Whatever the interpretation of its mechanism may be, the "fugitive perception" is a consequence of anatomic, physiologic and pathologic factors.

Contrary to the physiologic auditory fatigue, the transitory sensation when it appears at certain frequencies of the audiometric range does not affect hearing of any other frequency which was recorded. It is supposed to be connected with specific cochlear reaction verified at levels corresponding to that frequency at which the excitability is in a very weak stage. Its electiveness for some fatiguing tones seems to be

13. Stevens and Davis,[6] p. 219.

stronger than that observed by some investigators in cases of normal aural fatigue. Though this occurrence is more accentuated at the fatiguing frequencies, it may be extended over the surrounding frequencies and may even appear at those farther apart, with loss of the sensation.

The binaural nature of physiologic fatigue—which is an evidence of its connection with cortical factors—differentiates it from the evanescent phenomenon, which can be noticed in a single ear. This confirms our theory that the phenomenon is of sensorial or peripheral origin.

As we have shown, the "vanishing perception" by air conduction appears at the limit of the curve of "total loss of serviceable hearing." At this point the excitability is extremely weak (severe deafness), although it is the threshold of feeling in normal hearing. Under such a circumstance there is slight possibility either of stimulation of the sensory cells or of conduction of a nerve stimulus, at that limit of hearing. Besides, in the case of bone conduction we have to regard the fact that the sound loses intensity before reaching the cochlea, owing to the very structure and elasticity of the cranial bones, and to some other factors, even under normal hearing conditions. It is obvious that such a loss is made worse when one is dealing with perceptive deafness. We have verified that by bone conduction there is a greater number of appearances of the evanescent phenomenon; this fact indicates that this phenomenon is related to a deficiency of loudness.

It is often noticed, during our tests, that certain frequencies, namely, 256, 512, 1024 or 2048, which were being perceived fugitively more often when bone-conducted, could be recorded when air-conducted at higher levels of intensity—this being the only possible way to register the tones which we had utilized. The vanishing phenomenon can be attributed to a lack of the intensity necessary to a nerve impulse which is to maintain a continuous sensation.

This is observed first by bone and then by air conduction at the "maximum limit of auditory loss," and depends on the degree of development of the impairment. This accepted, the fugitive perception partakes of a series of progressive phenomena ending when the tones are no more perceived. It is a sign that the auditory loss is becoming worse, or rather it is the last stage of sensation of tones before the total disappearance of such sensation.

It is known that "the loudness produced by a tone exciting the ear must be directly related to number of fibers being excited and the rate at which the excitations occur, since each fibre always carries its maximum impulse" (Fletcher [14]). It may be accepted that in the

14. Fletcher, H.: Speech and Hearing, New York, D. Van Nostrand Company, 1936, pp. 126 and 127.

mechanism of the evanescent perception the temporary lack of intensity of nerve impulse is a result of poor excitability or conductability, having as its primary cause the anatomic lesions. It was only when this phenomenon was observed either with children or with adults whose nerve deafness was severe that we found these extreme conditions of loudness, excitability or conductability.

Summarizing, we may say that from an acoustic standpoint the vanishing perception is associated with a lack of sufficient intensity to support a steady sensation. From the physiologic and pathologic points of view it is related either to a very weak excitation of the hair cells of the organ of Corti or to a slight conduction of a nerve stimulus. From the anatomic point of view it is connected with the development of a degenerative process including both the nerve and the sensory organs.

AUDIOMETRIC STUDIES OF THE RESIDUAL HEARING OF PUPILS OF RIO DE JANEIRO NATIONAL INSTITUTE FOR THE DEAF

II. Study of the Progress of the Impairment of the Children's Hearing

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IN OUR first study [1] we accepted the progressive nature of the pathologic condition of the deaf-mute child. We also defined "vanishing perception" and its characteristics, stating that it partakes of a series of phenomena ending with the total loss of perception of audiometric tones. Successive tests trying to register repetitions of this fugitive sensation in the same audiograms and at the same frequencies led us to the verification of these facts. This explains why statistical data were taken from first and later audiometric tests, the purpose being to make sure of the reproduction of the evanescent perception.

It was through consecutive trials that we came to observe in many cases some new facts which later on we shall relate to the pathologic process of deaf children. Those facts may be stated thus: There is a falling off or a disappearance of the thresholds recorded in first tests. The latter may or may not be preceded by the vanishing perception.

The evanescent sensation was verified much more often at new audiometric positions than at the ones where it was previously observed. It reappeared one hundred and fifteen times by bone conduction, and sixty-one of these times it was in different frequencies and later audiograms. The remainder of the times, that is, fifty-four times, it was found as on the original charts, at the same frequencies, and mostly with no significant changes being noticed in the thresholds. By air conduction it was observed twenty times in later tests. Eighteen of these times it was found in later audiograms, together with the impossibility of obtaining the original marks. Relatively speaking, the vanishing sensation is found more times in later audiograms for air conduction than it is in

1. Lacerda, A. P., and Vervloet, A. E.: Audiometric Studies of the Residual Hearing of Pupils of the Rio de Janeiro National Institute for the Deaf: I., Auditory Acuity of Deaf Children, Arch. Otolaryng. **45**:239, 1947.

later ones for bone conduction. This is understandable since it appears in the former at a phase of the process which is far more advanced and which is characterized in the audiogram by a few scattered threshold marks observed near the curve of "total loss of serviceable hearing."

Contrary to what was suggested by Hughson, Ciocco and Palmer [2] in their "Studies of Pupils of the Pennsylvania School for the Deaf" —that "the process of impairment was not progressive"—our observations left no doubt that the process was advancing, though in a sluggish fashion. This is stressed by the fact that the children's lesions are of a degenerative type and therefore progressive. They have based their theory on the fact that "when the subjects are arranged in age groups 6 to 9 years, 10 to 14 and 15 and over, no significant differences are apparent between the average thresholds of the three groups."

We thought that it would be advisable to compare our pupils' original threshold curves with curves obtained after a period of time had elapsed, in order to note any significant change. Bearing this in mind, we started a new series of experiments. The time intervening between the audiometric tests varied from one to five years, and all our attention was devoted to the slightest change of the threshold curves as determined by comparing these with the ones previously registered. The results recorded in most of the later audiograms indicate that:

(*a*) There was an increasing auditory loss, an evident sign of progressiveness.

(*b*) The characteristics of the loss could be determined from an analysis of the findings in air and bone conduction tests.

Here, as in the previous work, we made sure that an accurate technic and the same instruments were utilized. The cases which we thought were more typical and the ones in which there were significant changes of auditory thresholds will now be described:

CASE 1 (O. D., a 17 year old boy; etiologic diagnosis, congenital syphilis).—The first test was made on June 6, 1939; the second, on Dec. 3, 1943; the third, on Dec. 30, 1944.

Air Conduction.—The audiograms obtained at the second test show no change. At the third test a difference of 15 decibels is noticed for the left ear at 1024 and 2048 cycles, and at the same time a threshold for 4096 cycles at 95 decibels has disappeared.

Bone Conduction.—At the second test, frequencies 128, 256 and 512 are still perceived by both ears, but the right ear now perceives 512 cycles in an evanescent way. At the third test both ears fail to perceive frequency 512, and the left ear, 128 cycles; these frequencies are noticed only transitorily. The thresholds for 256 at 30 decibels are now at 45 decibels.

2. Hughson, W.; Ciocco, A., and Palmer, C.: Studies of Pupils of the Pennsylvania School for the Deaf: Auditory Acuity, Arch. Otolaryng. **29**:403-416 (March) 1939.

Case 2 (A. R., a 13 year old boy; etiologic diagnosis, congenital syphilis).—The first test was made on Aug. 1, 1939; the second, on Dec. 5, 1943, and the third, on Dec. 6, 1944.

Air Conduction.—No significant changes are noted in thresholds of either ear in the audiograms obtained at the second and third tests.

Bone Conduction.—At the second test the curves, which had been exceptionally long at the first test, reveal that frequencies 128 and 1024 are no longer perceived in either ear; the same has happened to 2048 in the right ear and to 8192 in the

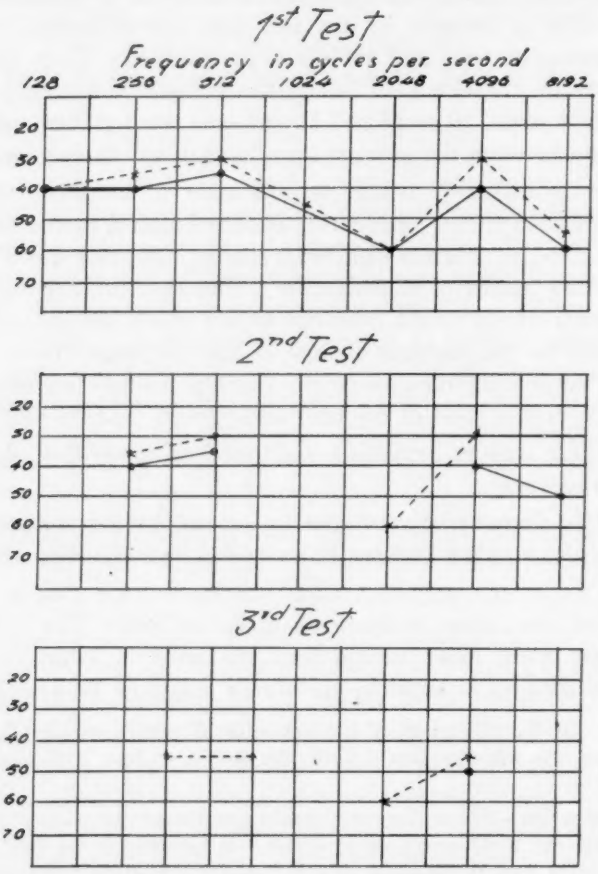

Chart 1.—Case 2. Threshold curves for bone conduction only. Left ear. broken line; right ear, unbroken line.

left ear. No appreciable change is observed in the other thresholds. At the third test we fail to record the thresholds of the right ear at 256, 512, 2048 and 8192 cycles. In the thresholds of the left ear at 256 and 512 cycles a difference of 10 and 15 decibels is noticed, respectively, and at 4096 there is a dip of 15 decibels for each ear. A vanishing perception was neatly observed in a tone gap at 2048 cycles in the right ear.

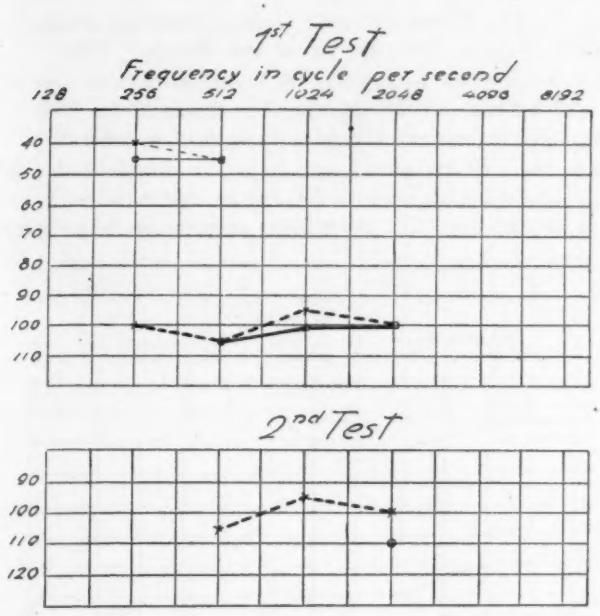

Chart 2.—Case 3. Threshold curves for bone and air conduction (light and heavy, respectively). Left ear, broken line; right ear unbroken line.

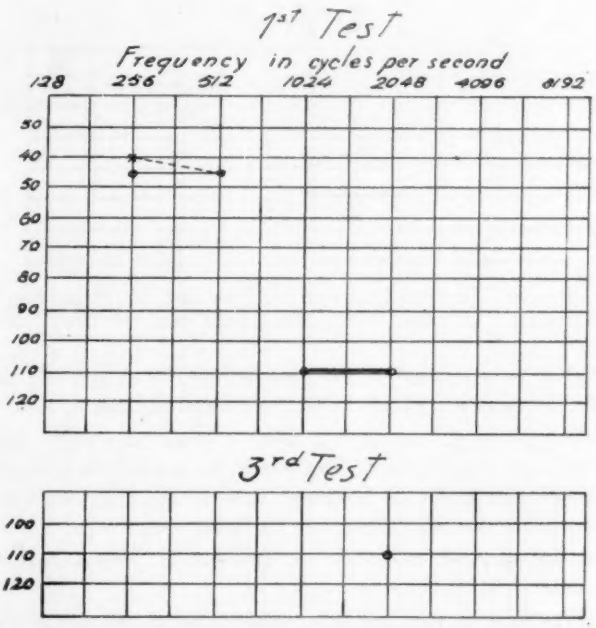

Chart 3.—Case 4. Threshold curves for bone and air conduction (light and heavy, respectively). Left ear, broken line; right ear, unbroken line.

CASE 3 (L. J. D., a 17 year old girl; etiologic diagnosis obscure).—The first test was made on Dec. 13, 1939; the second test, March 7, 1944.

Air Conduction.—In the second test the right ear fails to perceive 512 and 1024 cycles, and the left ear, 256 cycles. The threshold for 2048 in the right ear has fallen off 10 decibels and is now in the form of a "tonal island."

Bone Conduction.—In the second test, instead of thresholds for 256 and 512 in both ears, vanishing perception is noticed, an exception being made of frequency 512 in the left ear. The intermittent phenomenon is no longer observed at 1024 cycles.

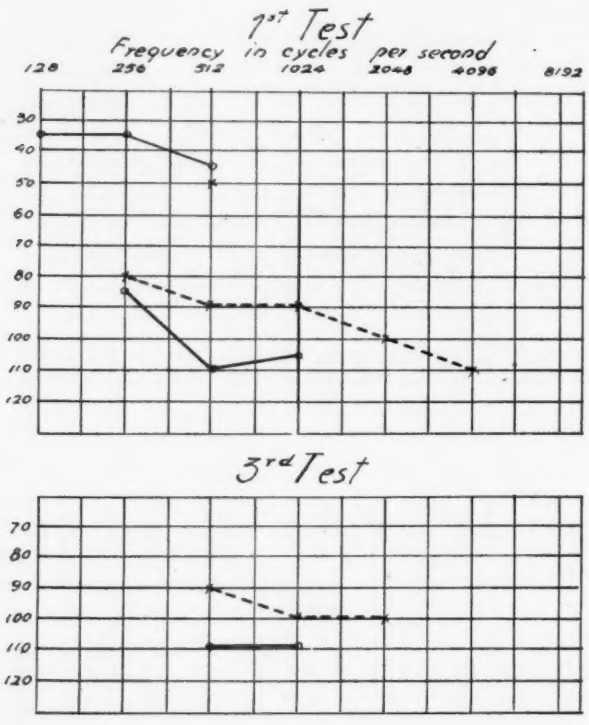

Chart 4.—Case 5. Threshold curves for bone and air conduction (light and heavy, respectively). Left ear, broken line; right ear, unbroken line.

CASE 4 (F. A. P., a 16 year old boy; meningitis).—The first test was made on Oct. 27, 1940; the second, on Dec. 3, 1943; the third on Dec. 5, 1944.

Air Conduction.—In the second test there is observed a slight falling off (5 decibels) in the only two thresholds registered for the right ear, at 110 decibels. In the third test perception of frequency 1024 is becoming fugitive; the only threshold recorded is that for 2048 cycles (a "tonal island").

Bone Conduction.—The thresholds for 256 and 512 cycles have disappeared in the second test.

CASE 5 (N. O., a 14 year old boy; infantile paralysis).—The first test was made on Dec. 22, 1940; the second, on Dec. 4, 1943; the third, on Dec. 30, 1944.

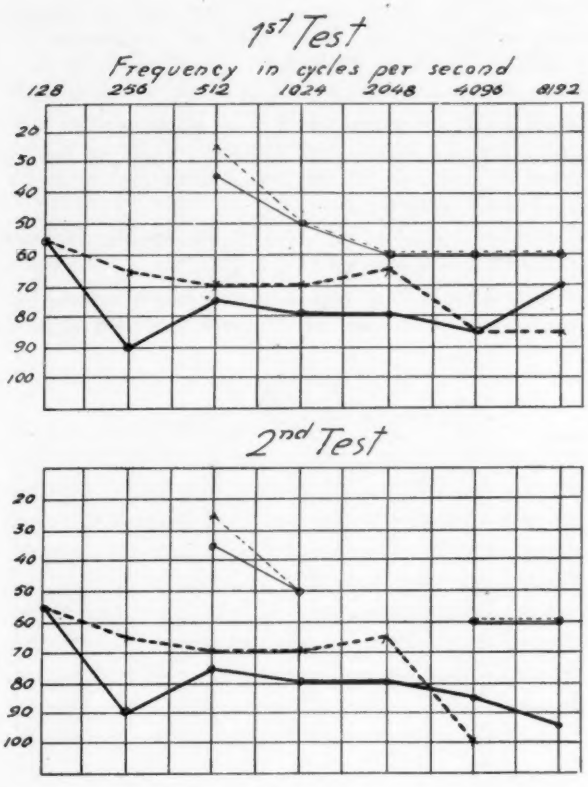

Chart 5.—Case 6. Threshold curves for bone and air conduction (light and heavy, respectively). Left ear, broken line; right ear, unbroken line.

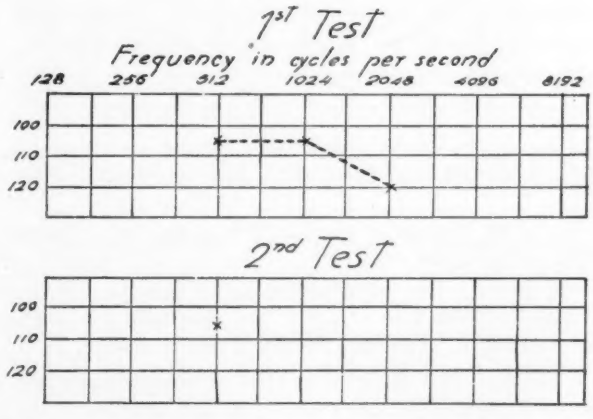

Chart 6.—Case 7. Threshold curves for air conduction only. Left ear, broken line; right ear, unbroken line (not shown).

Air Conduction.—In the second test a slight loss (5 to 10 decibels) is noticed in the thresholds of the left ear. In the third test frequencies 4096 (heard at 110 decibels) and 256 (heard at 80 decibels) are perceived in the left ear in a transitory fashion, and the threshold for 256 at 85 decibels in the right ear.

Bone Conduction.—At the second test it is no longer possible to obtain threshold for 256 and 512 cycles in the right ear and for 512 in the left ear. Frequency 128, heard so clearly in the first test, became fugitive in the second and was not perceived at all in the third.

CASE 6 (G. F. S., a 12 year old boy; hereditary alcoholism).—The first test was made on Oct. 28, 1942; the second, on Dec. 2, 1944.

Air Conduction.—Changes are noticed in the long threshold curves of both ears at the second test. Frequency 8192 is now perceived evanescently in the

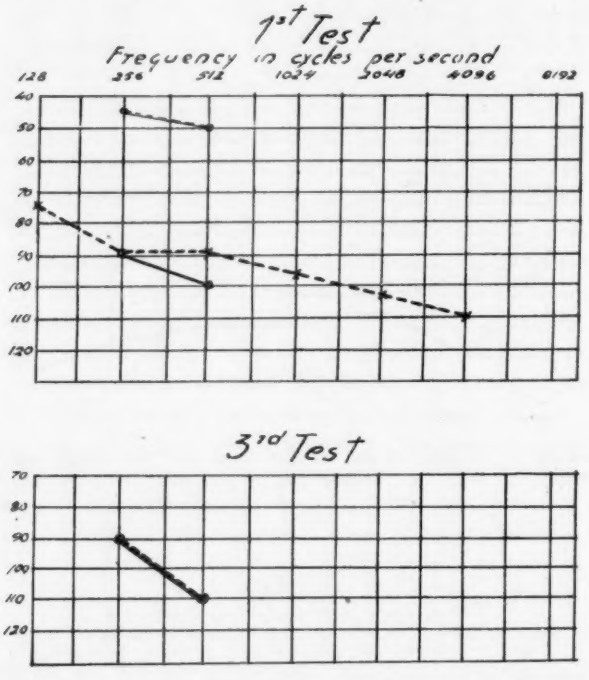

Chart 7.—Case 9. Threshold curves for bone and air conduction (light and heavy, respectively). Left ear, broken line; right ear, unbroken line.

left ear; a loss of 15 decibels is seen at 4096 cycles, and a greater one of 25 decibels at 8192 cycles, in the right ear.

Bone Conduction.—In the threshold curves of both ears exceptionally long "tone gaps" appear at 2048 cycles, and at the same time a vanishing perception occurs in that frequency. The other thresholds do not change.

CASE 7 (I. D. M., a 16 year old boy; etiologic diagnosis, obscure).—The first test was made on Nov. 4, 1942; the second, on Dec. 6, 1944.

Air Conduction.—Three thresholds are recorded at higher intensities of 512, 1024 and 2048 cycles in the first test. In the second test the first of them is still registered as a "tone island"; the second is now a fugitive perception, and the third has entirely disappeared.

Bone Conduction.—No thresholds could be recorded.

CASE 8 (P. B. S., a 14 year old boy; congenital syphilis).—The first test was made on Nov. 11, 1942; the second, on Dec. 4, 1944.

Air Conduction.—In the long curves the threshold for 4096 cycles at 110 decibels is no longer present, having become fugitive in both ears. The same occurs with frequency 128 heard at 40 decibels in the right ear. The thresholds for 256 and 512 cycles of the left ear have fallen off 15 and 10 decibels, respectively.

Bone Conduction.—In the left ear frequency 128 and in both ears 512 have completely disappeared. We still see a threshold for 256 at 45 decibels.

CASE 9 (P. P., a 13 year old boy; congenital syphilis).—The first test was made on Dec. 12, 1942; the second, on Nov. 30, 1943; the third, on Dec. 12, 1944.

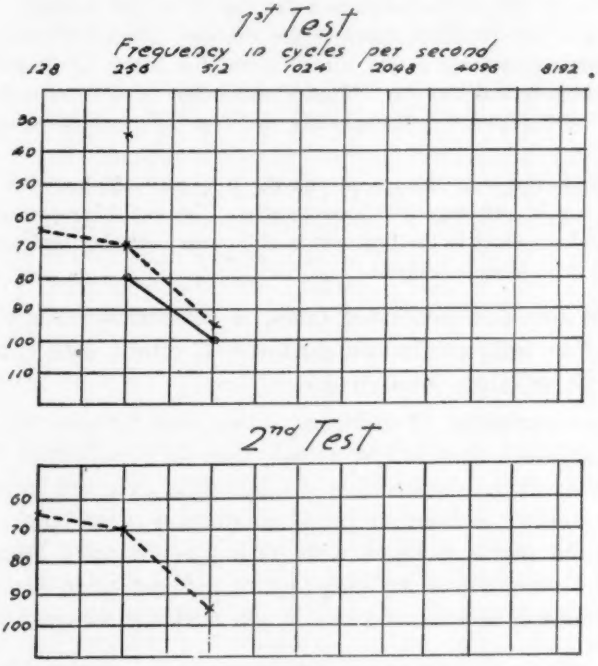

Chart 8.—Case 11. Threshold curves for bone and air conduction (light and heavy, respectively). Left ear, broken line; right ear, unbroken line.

At the second test the air and bone conduction thresholds remain unchanged. Frequencies 1024, 2048 and 4096, previously perceived in an evanescent way by bone conduction in the left ear, are still heard in a similar fashion.

Air Conduction.—At the third test (left ear) the thresholds for 1024 cycles at 110 decibels, 2048 at 105 decibels and 4096 at 110 decibels become evanescent and that for 128 at 75 decibels is no longer perceived. In both left and right ears the threshold for 512 cycles has fallen off, respectively, 20 and 10 decibels, and is now situated at 110 decibels.

Bone Conduction.—At the third test, neither frequency 256 nor frequency 512 was perceived, nor was vanishing perception noticed in either ear.

CASE 10 (J. D. R., an 18 year old boy; congenital syphilis)—The first test was made on Nov. 25, 1942; the second, on Dec. 8, 1943; the third, on Dec. 5, 1944.

Air Conduction.—In later tests fugitive perceptions take the places of the thresholds for frequency 128 at 60 decibels and frequency 1024 at 110 decibels in the right ear, and the threshold for 128 at 65 decibels is no longer obtained, and that for 256 at 75 decibels has fallen off 20 decibels, in the left ear.

Bone Conduction.—Since the second test, evanescent perception is observed instead of the two thresholds recorded for the right ear (that for 256 at 40 decibels and that for 512 at 50 decibels).

CASE 11 (A. S. M., a 16 year old boy; congenital syphilis).—The first test was made on Nov. 25, 1942; the second, on Nov. 30, 1943; the third, on Jan. 6, 1945.

Air Conduction.—At the second test, two thresholds of the right ear are missing (that for 256 at 80 decibels and that for 512 at 100 decibels); no changes are observed in the threshold curve of the left ear. At a third test, instead of three remaining thresholds of the left ear (that for 128 at 65 decibels, that for 256 at 70 decibels and that for 512 at 95 decibels) we observe a fugitive perception at the last two thresholds, while the first threshold has completely disappeared.

Bone Conduction.—At the second test the frequency 256 heard at 35 decibels in the left ear is now perceived evanescently. The vanishing perception of 512 and 4096 cycles noticed in the first test is still there. At the third test, sensation of any kind is no longer observed.

Besides the aforementioned cases, a comparative study of losses by air and by bone conduction disclosed 32 others with results somewhat like those in the cases cited.

We have examined 95 children. They were the ones whose audiograms were taken first and in whose cases the possibilities for further tests were verified. Appreciable changes were observed in audiograms of 43 boys either in bone or in air conduction or in both. With the remaining 52 pupils changes were negligible or nil. Most of these pupils—the ones whose auditory acuity did not alter—went through acoustic training of various kinds in the auricular classes,[3] and others

3. We may say that the acoustic training plays an important role in preserving the auditory curves of deaf children who have usable residual hearing. This is easily understood if one bears in mind the acoustic stimulation, mainly an intensive one, exerted by modern amplifiers of sound, which are now in use in the auricular classes.

However, it was Goldstein's opinion that: "After a residual-hearing child has been trained for four or five years in the acoustic method and another audiogram is made for otological check-up, it is found that the actual physiological hearing as indicated by the audiogram has not been increased. On the contrary, in some instances the audiogram shows further deterioration in the physiological hearing capacity. Our conclusion then must be that the ability of such a child to acquire speech through his ears is not an increased capacity for physiological hearing but is his mental education for the appreciation of spoken language." And Clarence O'Connor said: "It is pretty generally accepted by all today, how-

were under active antisyphilitic treatment, this being suggested by the anamnesis and clinical signs. These factors have certainly contributed to the maintenance of the curves.

In cases 2 and 6 the curves for bone conduction are exceptionally long ones. The progressive impairment takes place in the form of "tone gaps" and "tone islands." These tone gaps, together with the other losses, show that the curves are taking an aspect more characteristic of the perceptive type of deafness, with a tendency for the bone conduction curve and the threshold marks of higher tones to disappear.

From the analysis of all the data obtained in these cases we may state that no apparent association was found between the advance of the impairment and the stated causes of the congenital or the acquired deafness.

No constant relation was observed between the amount of the loss and the time elapsed between tests. As an illustration we may point to the fact that audiograms taken at an interval of from three to five years and others taken at an interval of two and even one year have no significant difference among them. The losses were about the same in aspect and in intensity. This fact shows a difference in the rate of development of the process. Such a difference may be attributed to the amount of hearing first recorded, personal influence and some strange factors associated with the causation and the pathogenesis of the deafness, the relationship of which to auditory curves is not well established.

So far as the change of curves for bone and air conduction is concerned, the audiometric findings gave valuable information. In the majority of audiograms the bone conduction curves were not only the first but the more seriously damaged by the process. This explains why in so many cases an early and marked impairment is noticed in hearing for bone-conducted tones, which has constituted a characteristic feature of deaf children's thresholds. In all cases in which the air conduction curve was modified and thresholds for some frequencies were no longer registered, the bone conduction curve had gone through a much more accentuated change. A good example of this is seen in

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ever, that for the large majority of the pupils in schools for the deaf the major objective of acoustic training is the development of better speech and that in aiming for this one objective intensively, through the seeing-hearing method, all the other objectives will be reached to the fullest extent possible."

We cannot deny the importance of the pedagogic objectives. Not less important from an otologic standpoint is the improvement of the functional, or physiologic, activity of the ear, as stated by Urbantschitsch. Chances are better for children who have a greater amount of hearing and for the hard of hearing ones. In such cases it would be reasonable to think of a favorable influence of acoustic training on the audiometric curves.

the audiograms of case 4. In those when the thresholds for bone conduction can no longer be recorded, a threshold for air conduction is still present.

In audiograms characterized by long bone conduction curves, the high tones are the first to fail to be recorded. In the usual cases of shortened bone conduction, restricted to frequencies 256 and 512, a tendency was observed for the thresholds of these tones to disappear completely. This fact may explain why the bone conduction curve was not registered in many audiograms taken in the early tests, as well as the exclusion of higher tones that was observed in the deaf children's median threshold curve.[1]

The loss is first noticed in the bone conduction curve from the high toward the low tones, and it reaches the air perception curve in a more advanced stage of the process. A marked degree of impairment of bone conduction was also observed in the remaining 32 audiograms having pronounced changes in the curves, as in the 11 cases already described.

In cases 2 and 6 the places of thresholds for high frequencies were gradually being taken by gaps. In these gaps the vanishing perception occurred, this being the first sign of the total loss of the sensation, occurring just before perception has completely vanished.

The cases in which air conduction was similarly modified have the characteristics of those already described with regard to bone conduction. In case 3 the "tone island" at 2048 cycles is a result of the disappearance of thresholds of the right ear. In case 4 the "tone island" remained at 2048 cycles. Other "tone islands" are observed in cases 5, 7 and 9, this because high tones have disappeared.[4] In cases 5, 8 and 10 the progressiveness is more marked at the ending of the curves.

Nevertheless, we may say that both air and bone conduction have followed the same general pattern; that is, the loss of acuity is greater for the high tones of the frequency range. An early marked impairment of hearing by bone conduction is also observed. These facts are in agreement with the opinion of the majority of authors who have studied the perceptive type of hearing loss (Bonnafont, Moos, Lucae, Habermann, Bezold, Helmholtz, Baginski, Burckardt-Merian, Gradenigo, Alexander, Manasse, Crowe, Guild, Polvogt, Oda, Bunch and Ciocco).

Here again, the "vanishing perception" reappears in the majority of instances—cases in which progressiveness is present—more in other

4. The displacement of "tone gaps" and "tone islands" observed in some audiograms of the first tests has become more characteristic during the progress of the impairment. This is the aspect taken by the auditory curves in cases in which the process is advancing in an uneven fashion in some tonal bands of the audiometric field. The "tone gaps" and the "tone islands" formed by the development of the deafness, together with the evanescent perception, may be regarded as signs associated with the progress of impairment.

frequencies and in later audiograms than in the ones in which it was previously observed. Of one hundred and fifteen times it showed up in the subsequent tests of bone conduction, seventy-seven were related to advancing processes. Sixty-one of these times it was found in new frequencies, mainly 256 and 512, where an absence of thresholds was verified, though in the early tests and at the very same frequencies these thresholds outnumbered any other ever recorded. In the remainder, that is, sixteen times it stayed in the same frequencies and audiograms. It is obvious that the evanescent phenomenon recurs much more at the same frequencies in cases in which the impairment is said to be stationary. While it recurred only sixteen times in 43 cases of a progressive impairment, it was noted thirty-eight times in 52 cases in which the changes were negligible or nil. Case 9 is a typical one. In the first stage, the one in which no changes occur, the evanescent perception reappears at the same positions. This is not observed in the second stage, characterized by a fast advancing impairment, which reaches the thresholds of perception of air-conducted tones.

The vanishing phenomenon was observed by air conduction in later tests twenty times, and nineteen of those times it replaced thresholds which were just vanishing, this being one of the signs, and sometimes the only one, of progressiveness in those audiograms (cases 4, 5, 6, 7, 8, 9, 10 and 11).

Every time the evanescent sensation failed to be perceived in frequencies in which it had previously been observed, the impossibility of recording it was also verified. This is a hint that a definite loss of sensation has taken place.

The evanescent appearance, when discerned by bone conduction at higher levels of intensity, as it often is, has the same characteristics as when observed at the maximum loss levels by air conduction. In cases 4 and 7 it was perceived at one of those scanty thresholds situated near the "curve of total loss of serviceable hearing." In case 8, with long threshold curves, the fugitive perception was observed by air conduction at two frequencies in which thresholds were recorded at high levels of intensity, proximal to the curve of maximum loss for these tones. The same was observed in cases 5, 9 and 10. So, it can be stated that the vanishing sensation at this upper limit of perception of air-conducted tones is the extreme condition of the sensation before the complete loss of hearing. It can be regarded as a transitory stage between the auditory threshold or, better, the audiogram mark and the complete disappearance of this mark. It is therefore a link in the chain of the progressive phenomena, that is: a threshold of hearing for a tone at a very high level of intensity, then a failure to record it, followed by the evanescent perception and finally the definite loss of sensation.

The bone conduction, the impairment of which is a first stage in the process, is more likely to have the vanishing sensation as well as a greater disappearance of thresholds, contrary to what is observed with air conduction, the impairment of which is the end of the road, where the chances for similar phenomena are fewer.

The transitional stage of bone conduction—that is, the stage in which the evanescent sensation takes the place of an old threshold depends on a factor of an acoustic nature or, better, on lack of the intensity necessary if the nerve impulse is to keep up a steady sensation. The same is later on, in the final phase, observed with air conduction.

It was noticed in many cases that a certain frequency was not perceived or was perceived in a fugitive way by bone conduction; then, if we tried it by air conduction, a threshold was recorded for the very same frequency, though at a higher level, which was the only possible way to register a threshold for the tone. This explains why a greater number of records was observed in air conduction curves and is an evidence of deaf children's auditory loss; this was also true in some cases of deafness of the perceptive type.

It is obvious that there is needed an intensity high enough to allow a threshold to be recorded or to maintain a steady sensation when one is dealing with the evanescent phenomenon.

This definite or temporary loss of the perception is first observed by bone conduction. Later on, depending on the degree of development of the impairment, it is observed by air conduction. The process so far as it has been analyzed may be divided into four main phases. In doing this we have taken as a starting point the most usual type of the deaf children's audiograms, corresponding to the median established in the first paper. The first phase is the one in which the thresholds, or marks, at high levels for bone conduction disappear (mainly those for frequencies 256 and 512), and this disappearance may or may not have been preceded by the vanishing perception. The thresholds for air conduction do not show any significant change. The second phase is characterized by the absence of records for bone conduction; only the air conduction thresholds are seen. These are somewhat widely placed, being spread over the frequency range at different high levels of intensity. The third phase shows the process more advanced. Only a few scattered marks are observed in the neighborhood of the threshold of sensation. Little by little they are being eliminated. This development takes place with or without evanescent perception, as was observed with bone conduction, though here the fugitive perceptions have a different meaning, for they signify the final stage before the complete disappearance of hearing. The fourth and last phase is constituted of the absence of marks and the "total loss of serviceable hearing." According to the data we have, those would

be the fundamental phases of the progressive impairment. Deviations from them may be found in our daily tests though they present the same basic features.

The progressive impairment is in most cases of a sluggish nature. Besides, it must be borne in mind that different factors may influence its progress by speeding it up or slowing it down. There is still the possibility that in one of these phases it may remain stationary. Among these elements an important one is the age of onset of the impairment —that is, whether the child has an acquired or a congenital type of deafness. Another, not less important, is the site of the lesion when this is attributed to different etiologic factors in childhood, as well as to constitutional damages and changes acquired during intrauterine life. In other words, the etiologic and pathogenic mechanism and the biologic constitution of deaf children are important elements in the development of the auditory pathologic process.

These different angles of the problem are, by themselves, enough to warrant further research and a more accurate study of this subject. Our first results were restricted to the comparative study of the auditory loss and its characteristics by air and bone conduction tests in the diagnosis of this type of deafness. However, they have suggested new experiments which might be undertaken in the measurement of auditory acuity and further clinical studies which might bring a new source of light into the pedagogy and the therapeutics of deaf children.

In our coming experiments in this obscure field we shall take up the subject in its scientific details, not overlooking the clinical aspect, which seems rather important to us. Then we shall be able to make a far more accurate study of the facts heretofore observed and to investigate the new ones. We shall try to settle more definitely the matter of the association of the rate of progress with the age of onset of the impairment and the etiologic and pathogenic factors responsible for the auditory lesions in deaf children. We shall also consider a matter which has been the subject of delayed attention, the great help that acoustic training and specific treatment may bring in cases in which the process has become stationary.

Some features that we and other authors have observed in connection with the good results obtained from the auricular method, that is, the better use of deaf children's residual hearing, entitle us to accept the possibility of the maintenance of audiometric curves. This was especially observed with children who underwent acoustic training and those who received auditory stimuli from various sources. Furthermore, in dealing with such patients there is the possibility that one may obtain improvement of the physiologic capacity of the ear. This is done through pedagogic training and adequate therapeutics, provided rational means are used. Some careful thinking should be devoted to these mat-

ters by those who intend to carry on such experiments, since the results accomplished in this particular field seem to warrant further investigations, however difficult the approach may be.

SUMMARIES AND CONCLUSIONS

The hearing of 241 boys and girls of the National Institute for the Deaf, Rio de Janeiro, Brazil, was examined with respect to both air and bone conduction. The ages ranged from 7 to 21 years. The audiograms of 200 children who gave satisfactory responses served as the basis for a statistical analysis which was undertaken for scientific purposes.

We have obtained 379 threshold curves by air conduction and 233 by bone conduction. Charts made from the statistical data show air conduction curves longer than bone conduction curves. Noticeable is a greater loss of hearing for high tones by both air and bone conduction.

The charts show that in the majority of these children the loss of hearing is bilateral and approximately equal in the two ears by both air and bone conduction.

It was verified that 97.5 per cent of the children responded to at least one tonal frequency in one ear when tested by air conduction. Only in 2.5 per cent of the audiograms was no response to auditory stimulation registered in either air or bone conduction trials.

Seventy per cent of the children examined were said to have been born deaf. The percentage of those who presumably acquired the deafness after birth is about 30 per cent. The differences among the children's audiograms of both groups are not regarded as significant.

No significant difference in the threshold curves of the two sexes is to be noted. There is no apparent association between etiologic factors and the audiometric curves.

The audiometric curves give a picture of the functional disturbance of the perceptive type of deafness. This is commonly observed in connection with pathologic mechanisms resulting from damage of the auditory nerve or of the hair cells of the organ of Corti, or from a process involving them.

A slight and transitory perception which we found unrecordable was noticed mainly in tests of bone conduction. Due to its peculiar behavior we named this very especial auditory phenomenon "vanishing perception" of audiometric tones.

The vanishing perception, from an acoustic standpoint, is associated with a lack of the intensity needed to keep up a steady sensation. From the physiologic and pathologic point of view it is related to a slight excitation of sensory cells or to a slight conduction of a nerve stimulus. From the anatomic point of view it is connected with the development of a degenerative process including both the nerve and

the sensory organs. It may be looked on as a sign of an inner ear nerve lesion which is observed in an advanced stage of deafness of the perceptive type, particularly in deaf-mutism.

The evanescent sensation is the last stage prior to the complete loss of sensation of the audiometric tone either by bone or by air conduction. In the instance of air conduction it is regarded as the extreme condition of the perception of the tone before the total disappearance of perception of this tone.

The fugitive perception partakes of a series of progressive phenomena ending with total loss of hearing. It is a transitory stage between the audiogram mark of a threshold and the complete disappearance of this mark.

Ninety-five children underwent subsequent audiometric tests. The time between tests ranged from one to five years. When the later audiograms were compared with the early ones, significant changes were noticed in 43 cases. They may be outlined: falling off of the marks, or thresholds, and disappearance of some of those previously recorded, sometimes preceded by the fugitive perception. That is an evidence of progress of the impairment. In the remaining 52 cases no change was observed. In these cases the pupils attended the auricular classes or were under active specific treatment.

On the basis of the analysis of all the findings in these cases we may state that no apparent association was found betwen the progress of the impairment and the stated causes of the congenital or the acquired deafness. No constant relation was established between the amount of the loss and the time elapsed between tests.

The general features of the advancing process are: an early marked impairment of perception of bone-conducted frequencies and a tendency toward a greater loss of perception of high frequencies whether conducted by air or by bone.

The process may be divided into four main phases according to the degree of the loss of hearing. Different factors, not well established, influence these successive phases by speeding up the process, slowing it down or holding it stationary.

These different aspects of the problem are, by themselves, enough to warrant further research and a more accurate study of the subject, with the results being applied to the pedagogy and the therapeutics of deaf children.

BONE-DUST-FREE LEMPERT FENESTRA NOV-OVALIS

A New Evolutionary Development of the Surgical Treatment of Clinical Otosclerosis

JULIUS LEMPERT, M.D.
NEW YORK

IN A DISCUSSION of osteogenesis following the fenestration operation in the human ear, in the May 1940 issue of the ARCHIVES OF OTOLARYNGOLOGY,[1] I stated:

> From my observations during revisions of the fenestra, I was forced to conclude that new bone regeneration within the fenestra begins not in the periosteal but in the endosteal layer of the bony capsule and either may stop there, without involving the periosteal layer, or may eventually involve the periosteal layer of the bony walls of the fenestra, . . .

In the November 1947 issue of the ARCHIVES OF OTOLARYNGOLOGY Lindsay,[2] in an analysis of his histologic observations of the results following fenestration of the labyrinth of the rhesus monkey, corroborated the observations which I had made in the human subject and stated:

> Failure to maintain an open fistula was in most cases due to the osteogenetic process which took origin from the endosteal surface at the margins.

In the surgical treatment of clinical otosclerosis, bone sand and bone splinters have always been the by-products of fenestrating the bony labyrinthine capsule with the electrically driven burr. When the final endosteal bony layer is fractured inward and pulverized, bone dust and bone splinters are pushed in the direction of the perilymphatic space, with most of them coming to rest on the shredded endosteal membrane and the endolymphatic labyrinth. It has been a well recognized fact that when these bone particles are not meticulously removed from the region of the fenestra they may stimulate and enhance the naturally existing tendency for osteogenesis to occur in the freshly cut bony walls of the fenestral rim.

It is for this reason that various methods of removing the fractured and pulverized endosteal layer of the bony capsule, which is seen resting on the shredded endosteal membrane and the endolymphatic labyrinth, are being practiced by otologists doing fenestration surgery.

Read at the Atlanta Postgraduate Medical Assembly, Atlanta, Ga., Jan 28, 1948.

Work aided by a grant from the Lempert Research Foundation, Inc.

1. Lempert, J.: Endaural Fenestration of External Semicircular Canal for Restoration of Hearing in Cases of Otosclerosis: Summary Report of One Hundred and Twenty Cases, Arch. Otolaryng. **31**:711-779 (May) 1940.

2. Lindsay, J. R.: Healing of Experimental Labyrinthine Fistulas: Further Observations, Arch. Otolaryng. **46**:584-600 (Nov.) 1947.

However, every careful otologist practicing fenestration surgery could not help but observe that in fracturing and pulverizing the endosteal bony layer of the fenestral region, bone dust and bone splinters unavoidably fall into the perilymphatic space and frequently disappear beyond visualization and retrieval.

Lindsay, after having made similar observations following experimental fenestration in the rhesus monkey, stated in the November 1947 issue of the ARCHIVES OF OTOLARYNGOLOGY [2] that:

> . . . The histologic examination has demonstrated that although at operation the technic appeared to be carried out faultlessly the complete removal of bone dust and fragments was rarely accomplished.

Attempts at removing bone splinters from the perilymphatic space often result in severance of some of the perilymphatic trabeculae and trabecular blood vessels, as a result of which blood escapes into the perilymphatic space.

The endolymphatic labyrinth can easily be injured by a bone splinter left within the perilymphatic space or torn in attempts to remove such a splinter from the perilymphatic space (fig. 3*A*).

As a result of making careful observations in the performance of 414 revisions of fenestrated human ears, as well as in histologic studies of the temporal bones of our experimentally fenestrated rhesus monkeys,[3] I am convinced that bone dust and bone splinters entering the perilymphatic space are a much more serious threat to the hope of obtaining and continuously maintaining practical serviceable hearing as a result of fenestration surgery than bone dust and bone splinters resting in the region of the fenestral rim. This is so because bony fragments lost in the perilymphatic space are often not removable, while bone particles in the region of the fenestral rim can, as a rule, be completely removed.

TWO CLINICAL PICTURES SUGGESTING POSTOPERATIVE OSTEOGENESIS

In my postoperative clinical study of the 3,400 patients on whom I performed fenestration operations, I was able to observe two distinct clinical pictures each of which could be indicative of an osteogenetic process that had taken place postoperatively.

Clinical Picture 1.—A patient who had practical hearing restored and who maintained this improvement at that high level for six months to a year suddenly begins to lose his hearing gain, and slowly his hearing acuity returns to the preoperative level and remains more or less at this level for some time.

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3. Lempert, J.; Meltzer, P. E.; Schall, L., and Wolff, D.: Osteogenesis Following Fenestration of the Vestibular Labyrinth of the Rhesus Monkey: A Controlled Experimental Study, Arch. Otolaryng. **46**:512-527 (Oct.) 1947

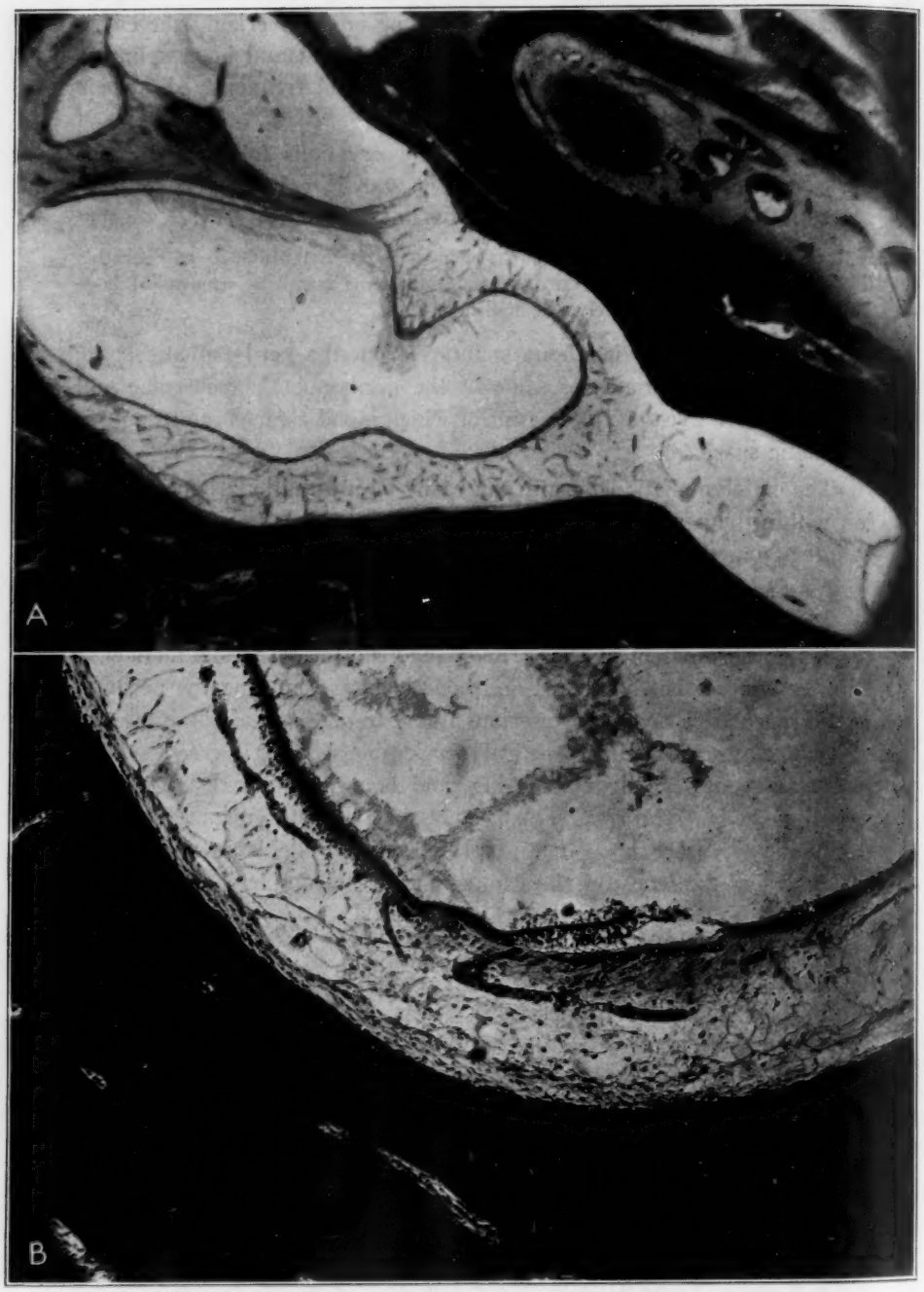

Fig. 1.—*A* and *B*, perilymphatic trabeculae and trabecular blood vessels normally present within the perilymphatic space of the external semicircular canal of an 8 month fetus.

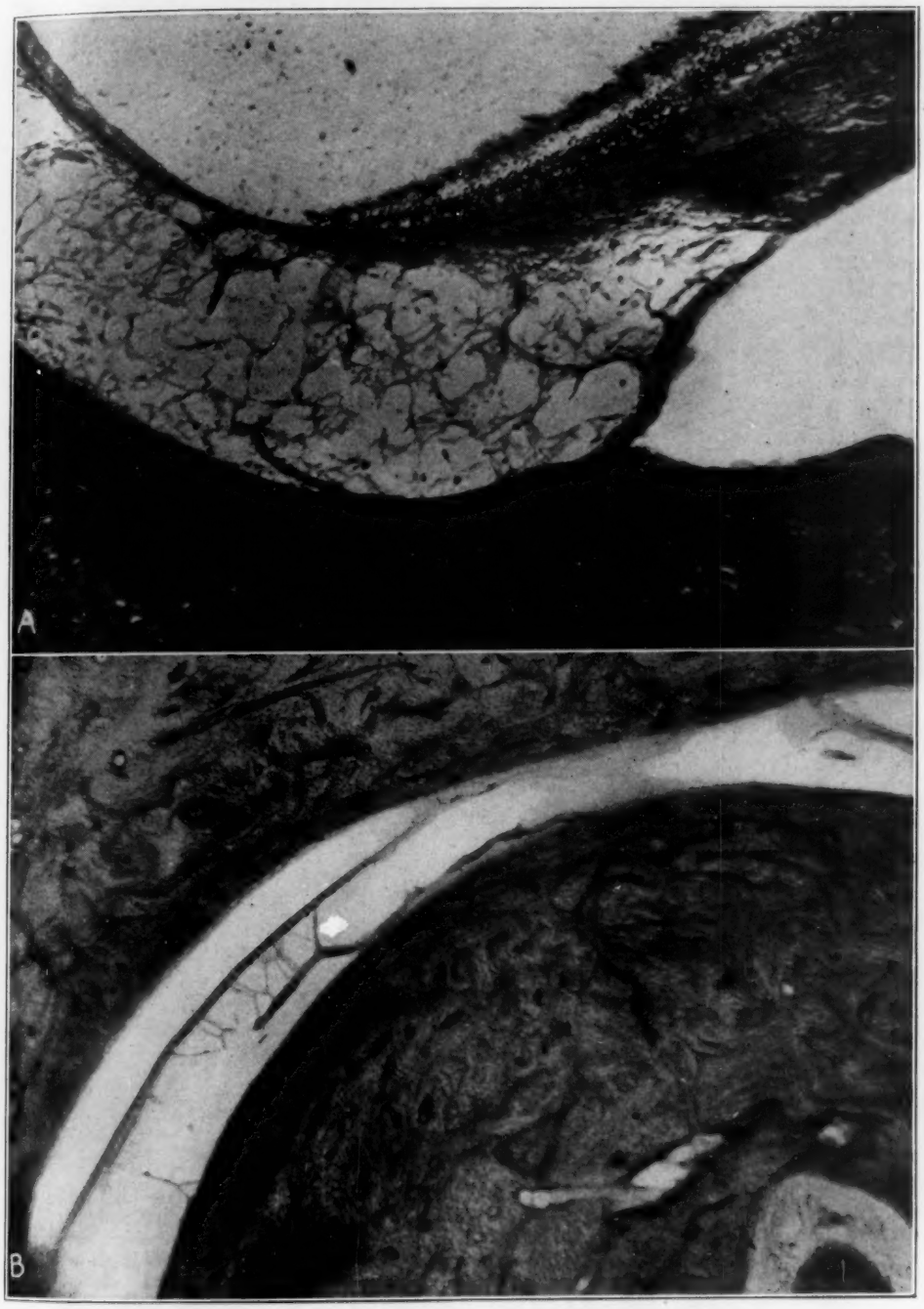

Fig. 2.—*A*, perilymphatic trabeculae and trabecular blood vessels normally present within the vestibular perilymphatic space of a 3 day old infant. *B*, trabecular blood vessels within the perilymphatic space of the crus commune of the right ear of monkey 21, W. L.

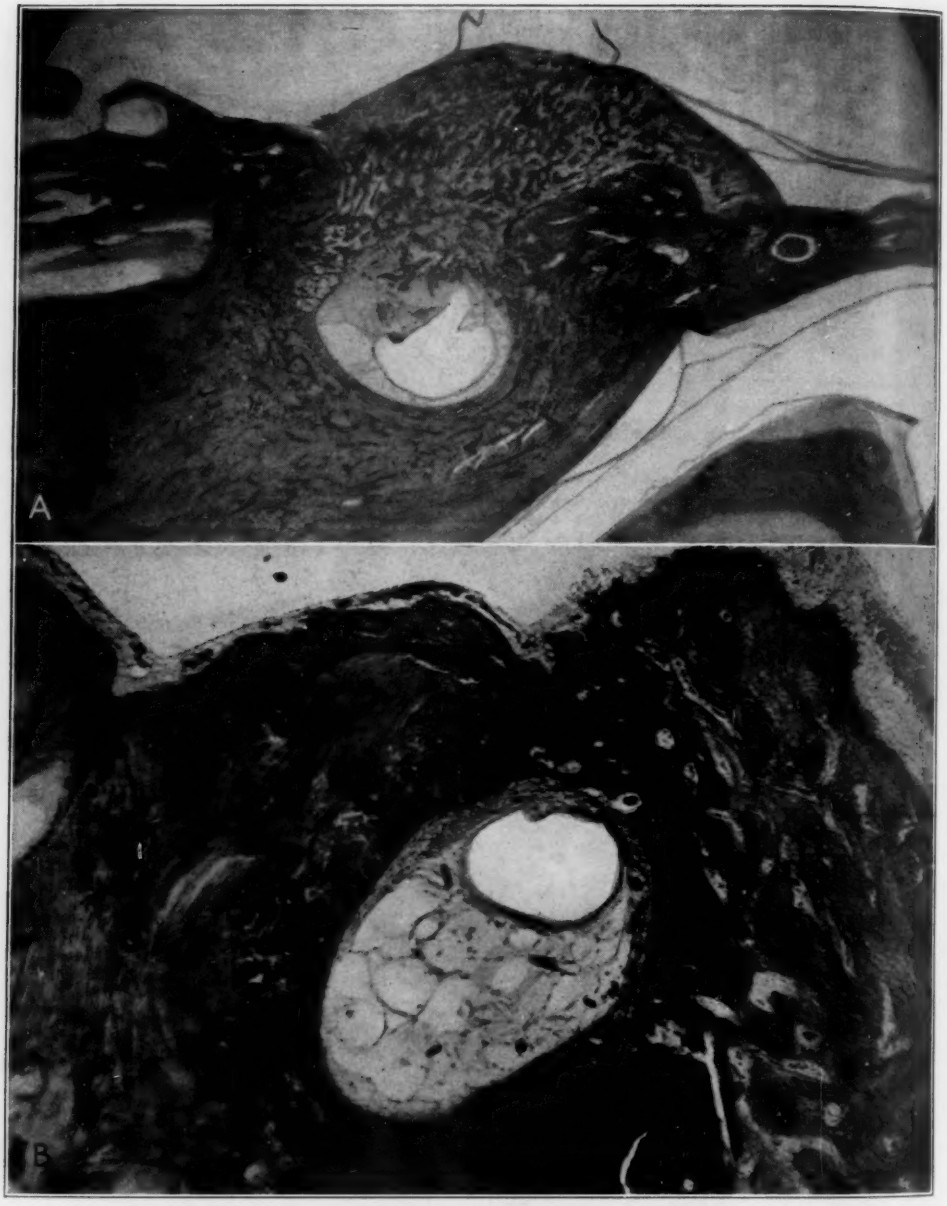

Fig. 3.—*A*, right ear of monkey 24, experiment II. Bone splinters which had been unavoidably lost within the perilymphatic space injured and distorted the endolymphatic labyrinth. Bone regeneration is complete at the rim of the fenestra. The fenestra is closed. *B*, right ear of monkey 28, experiment II. This shows the ideal postoperative state of the perilymphatic space of a fenestrated external semicircular canal. There are no bone fragments in the perilymphatic space. The endolymphatic labyrinth, the perilymphatic trabeculae and the trabecular blood vessels have remained undisturbed and uninjured. Osteogenesis has taken place only at the fenestral rim.

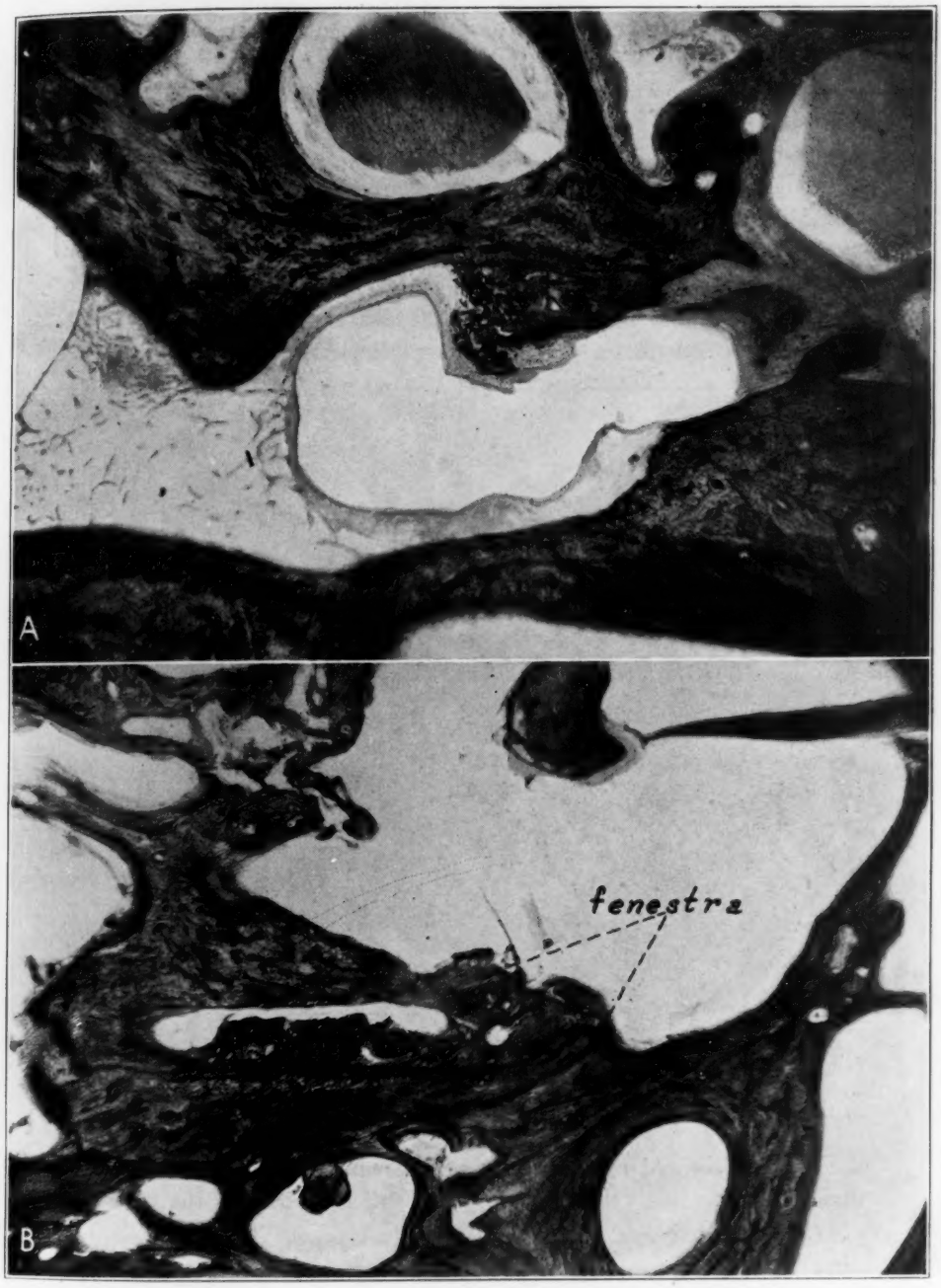

Fig. 4.—*A*, left ear of monkey 42, experiment III. Perilymphatic endosteal osteogenesis was incited by bone particles unavoidably lost within the perilymphatic space. No bone regeneration has taken place at the fenestral rim, and the fenestra remains patent. *B*, right ear of monkey 46. The perilymphatic space is almost completely occluded by endosteal osteogenesis, which was initiated by bone particles unavoidably lost in the perilymphatic space. Osteogenetic closure of the fenestra can be seen.

In the vast majority of patients presenting this postoperative clinical picture, inspection of the fenestral region during revisions revealed that bone regeneration was limited to the fenestral rim of the bony labyrinthine capsule. When the newly formed endosteal bony growth was removed from the fenestral rim the hearing as a rule immediately improved, and when osteogenesis did not recur, this improvement continued indefinitely. If osteogenetic closure of the fenestra took place once again, the hearing again receded to the preoperative level.

In a few patients belonging to this clinical group I found no bone regeneration of fenestral rim but observed some narrowing of perilymphatic lumen as a result of endosteal osteogenesis. In these

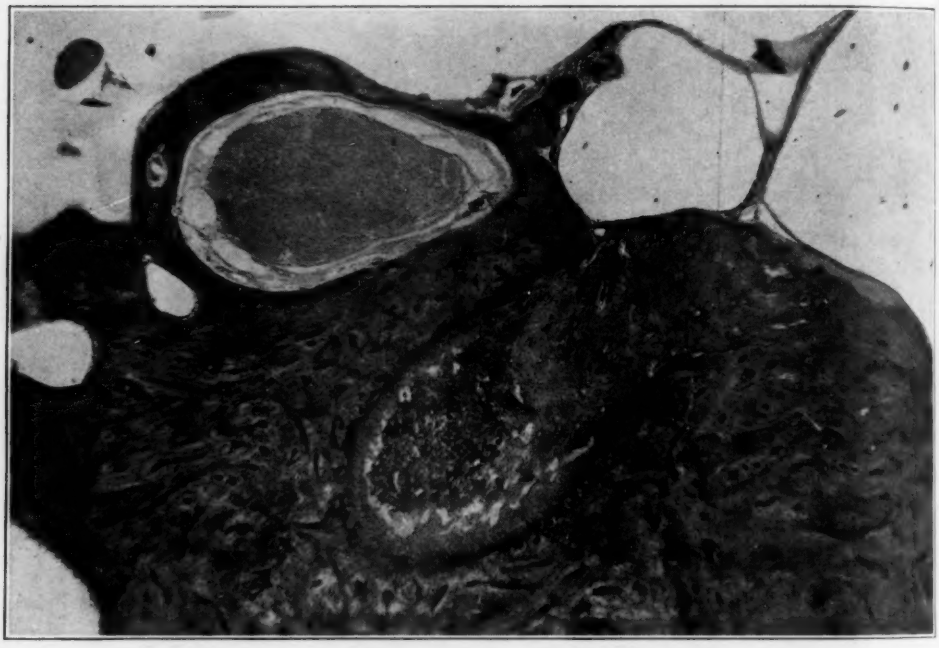

Fig. 5.—Right ear of monkey 29, experiment II. The perilymphatic space is completely occluded and obliterated by endosteal osteogenesis, which was instigated by bone particles irretrievably lost in the perilymphatic space. Bone regeneration at the rim of the fenestra is complete, and the fenestra is closed.

the hearing showed no improvement following revision, and not infrequently the hearing continued to recede still further after the revision.

Clinical Picture 2.—A patient who had practical hearing restored after the fenestration operation begins to lose his hearing improvement at the end of six months or so, and his hearing more or less rapidly reaches the preoperative level, but instead of remaining at that level for some time it continues to deteriorate to a level lower than that.

The abnormalities grossly observed with the aid of magnification on revision of the fenestra in such cases were usually of a more serious

nature. Here the osteogenetic process was observed to have involved extensively both the fenestral rim and the perilymphatic space. The hearing in these cases did not improve following revision and continued its downward trend.

In analyzing these findings in the two groups of patients it became obvious that, since I have always meticulously removed the bone fragments visualized in the region of the fenestral gap, the osteogenetic process observed in the bony fenestral rim was started by the inherently existing tendency for repair to take place within the freshly injured bony layers of the fenestral rim (fig. 3*B*).

However, the endosteal osteogenetic processes observed within the perilymphatic space during revisions of fenestrated human ears could not be explained on this basis, since injury to the endosteum-lined perilymphatic space is normally not part of my surgical technic. I therefore reasoned hypothetically that perhaps the perilymphatic endosteal osteogenetic processes which I observed in the human subject had been initiated by bone fragments that found their way unnoticed into the perilymphatic space.

Histologic studies of our experimentally fenestrated rhesus monkeys have confirmed my suspicions that irremovable bone fragments entering unavoidably and unnoticed and remaining in the perilymphatic space do create endosteal osteogenesis in the perilymphatic space, a nonremediable condition which when occurring subsequent to the fenestration operation in a patient is most damaging to the expected end results (figs. 4 and 5).

In view of the clinical and operating table observations made in the human subject after fenestration of the labyrinth for clinical otosclerosis and the histologic observations made in the fenestrated labyrinths of rhesus monkeys, it became obvious that just as long as the creation of the fenestra nov-ovalis involves fracturing inward and pulverization of the endosteal bony layer of the labyrinthine capsule some of the bone splinters and bone dust thus formed will frequently fall into the perilymphatic space and unavoidably disappear beyond retrieval within it.

In order to avoid the dire consequences and untoward end results observed, which were caused apparently by nonretrievable, unavoidably lost bone fragments within the labyrinthine perilymphatic space, I have gradually developed a new technic which I now exclusively employ for fenestrating the surgical dome of the vestibule without creating bone splinters and bone dust.

TECHNIC

STEP 1. *Creation of an Endosteal Bone Cupola on the Surgical Dome of the Vestibule.*—With an electrically driven 1 mm. dental polishing burr, the bony capsule of the surgical dome of the vestibule is gradually worn down to the endosteal bony layer, until it is thinned to a bluish gray transparency. The bony capsule

is then slowly and gradually worn down both anterolateral and posterolateral to the bluish gray transparent area until a bluish gray cupola of endosteal bone is created on the surgical dome of the vestibule. The bone dust formed is constantly removed by irrigating with saline solution and suction.

STEP 2. *Circumferential Incision of the Base of the Bony Endosteal Cupola.*—In an absolutely blood-free surgical field free from bone debris, the base of the cupola is incised as follows: The anterolateral aspect of the base of the cupola is pierced with a small sharp perforating knife in the direction of the perilymphatic space. A linear incision is then carried from the perilymphatic space outward through the endosteum and endosteal bone along the entire circumference of the base of the cupola.

STEP 3. *Eversion and Removal of the Intact Bony Cupola to Uncap the Perilymphatic Space and Expose to View the Endolymphatic Labyrinth.*—With a flat spatula-tipped excavator, the anterolateral margin of the base of the endosteal bony cupola is engaged, gently lifted and everted in a direction posterolateral to the fenestra and removed intact. The endolymphatic labyrinth, without having been disturbed from its normal position, is thus exposed to view.

STEP 4. *Lead-Burnishing of the Bony Fenestral Rim to Prevent Osteogenesis Within the Bone-Dust-Free, Freshly Cut Bony Rim of the Fenestra.*—With a pure lead burnishing burr held in an especially devised steel pencil holder, the bony rim of the fenestra is hand burnished.

ADVANTAGES

1. When this new technic is employed for creating the fenestra nov-ovalis, the endosteal bony layer of the labyrinthine capsule is neither fractured inward nor pulverized. Since no bone particles are formed, none can be lost in the perilymphatic space. Therefore, neither the endolymphatic labyrinth nor the trabecular blood vessels are ever in danger of being injured by bone splinters.

2. Since there are no bone particles to be lost in the perilymphatic space, endosteal osteogenetic processes formerly stimulated in the perilymphatic space by such bone particles are no longer possible.

3. With this technic, the endolymphatic labyrinth always maintains its normal position within the perilymphatic space.

4. Fenestration surgery can thus be performed without traumatizing the endolymphatic labyrinth, the trabeculae or the endosteal perilymphatic membrane.

SUMMARY

To further enhance the possibility of permanently maintaining the practical serviceable hearing following the Lempert fenestra nov-ovalis operation, (1) a new method of creating a fenestra in the vestibule of the labyrinth without producing bone dust and bone splinters is described, (2) the clinical and histologic factors influencing the necessity for its development are given and (3) the advantages expected to accrue as a result of this new evolutionary development are stated.

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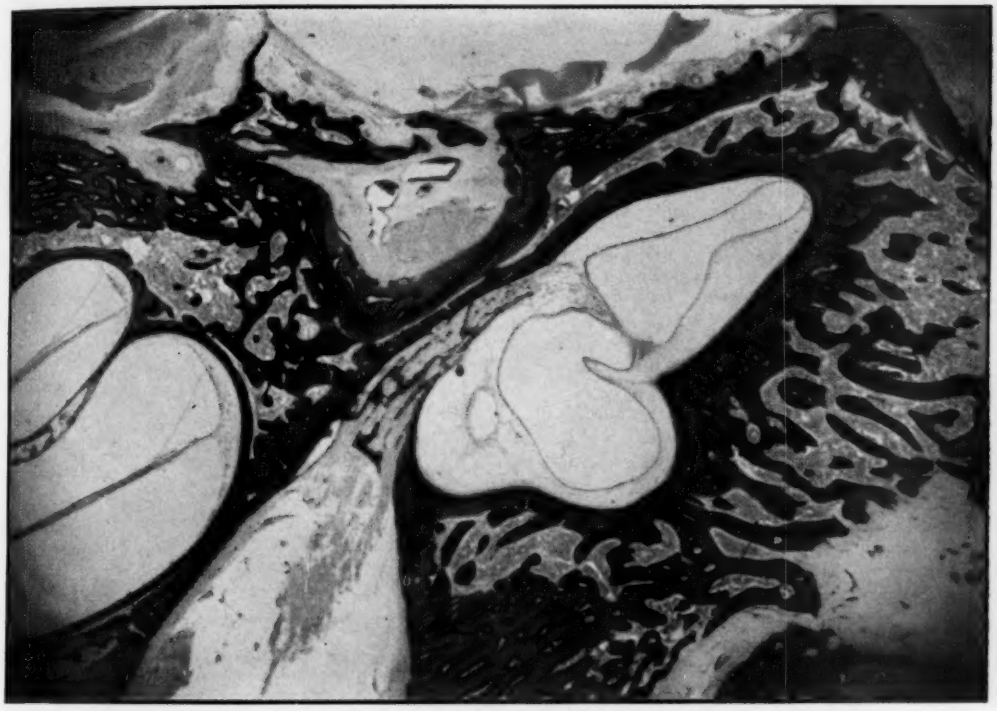

Fig. 6.—The three histologic layers of the bony capsule of the external semicircular canal, namely, the periosteal, enchondral and endosteal layers, are seen. The endosteal membrane lining the perilymphatic space of the external semicircular canal and vestibule is also seen. Within the perilymphatic space the endolymphatic labyrinth, consisting of external semicircular canal, utricle and saccule, are apparent. The crista of the external semicircular canal is seen crossing the ampulla.

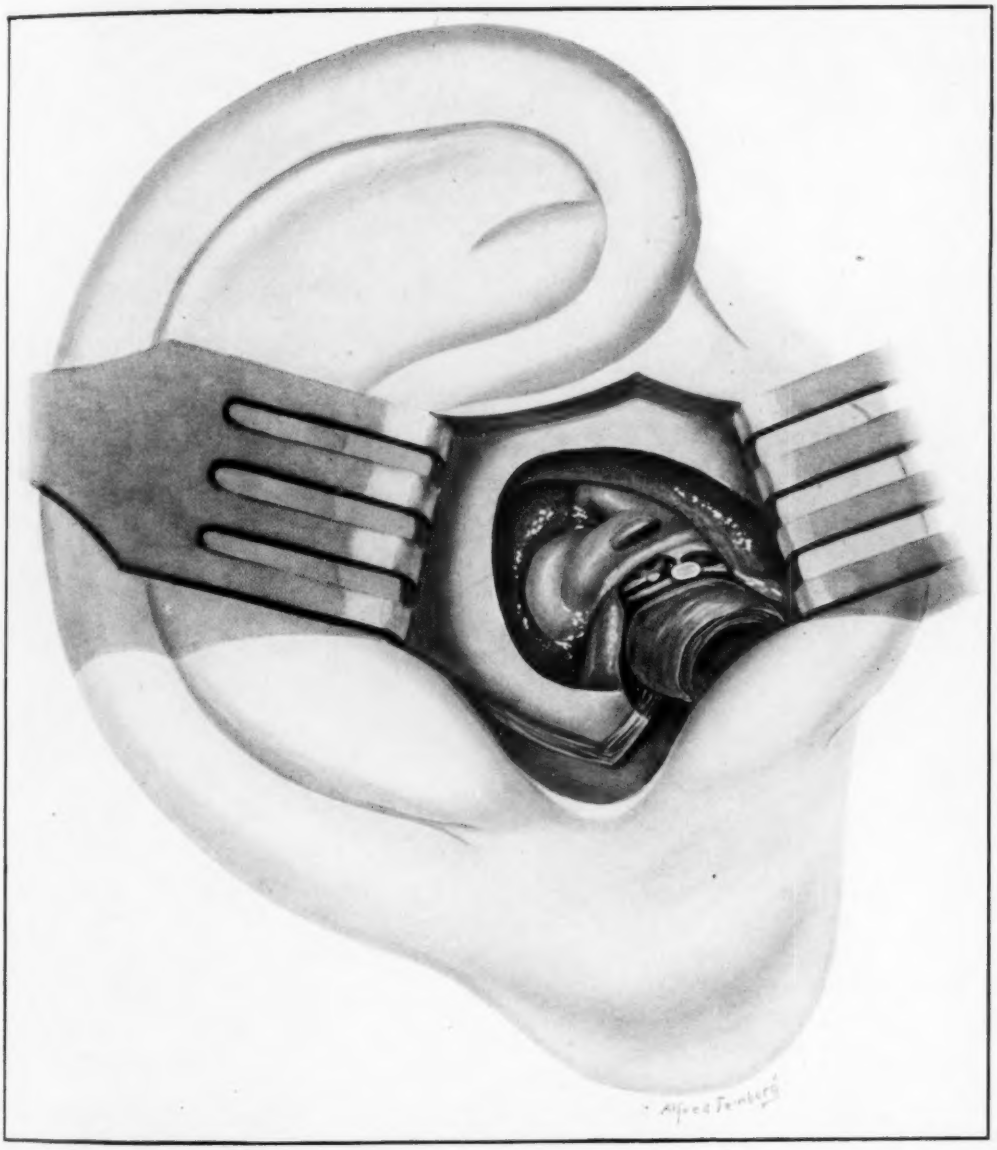

Fig. 7.—Step 1. An endosteal bone cupola is created on the surgical dome of the vestibule.

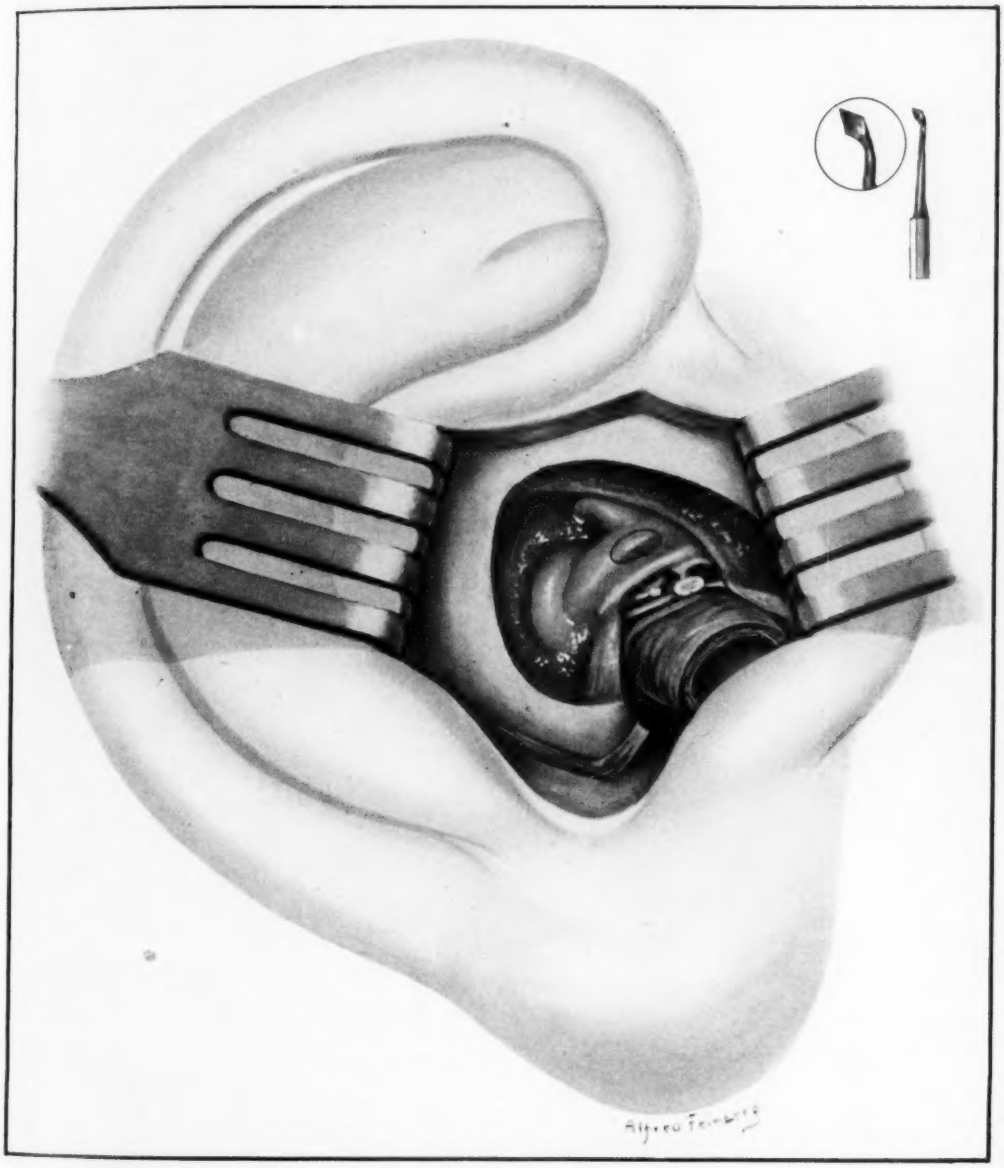

Fig. 8.—Step 2. The base of the bony endosteal cupola is incised circumferentially.

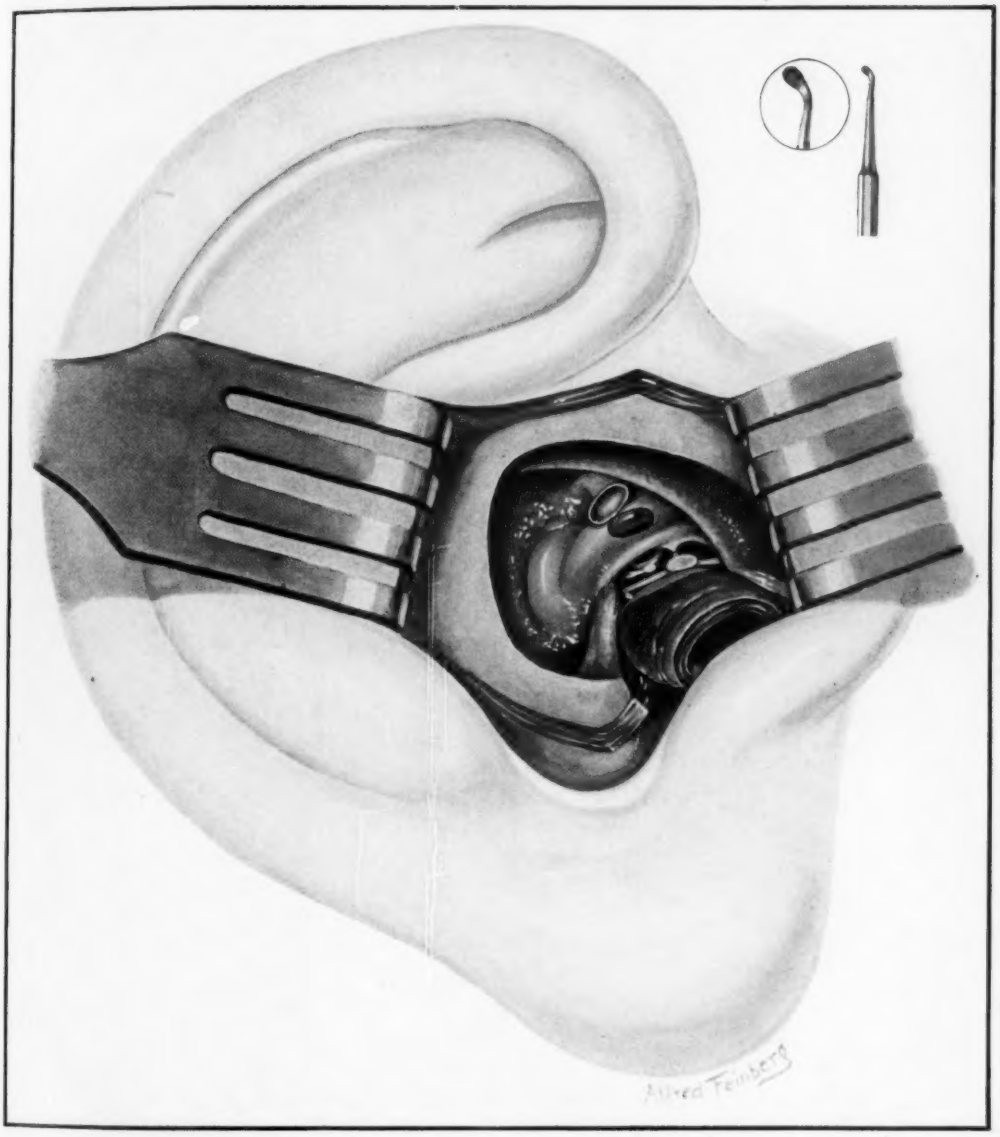

Fig. 9.—Step 3. The bony cupola is everted and removed intact to uncap the perilymphatic space and expose to view the endolymphatic labyrinth.

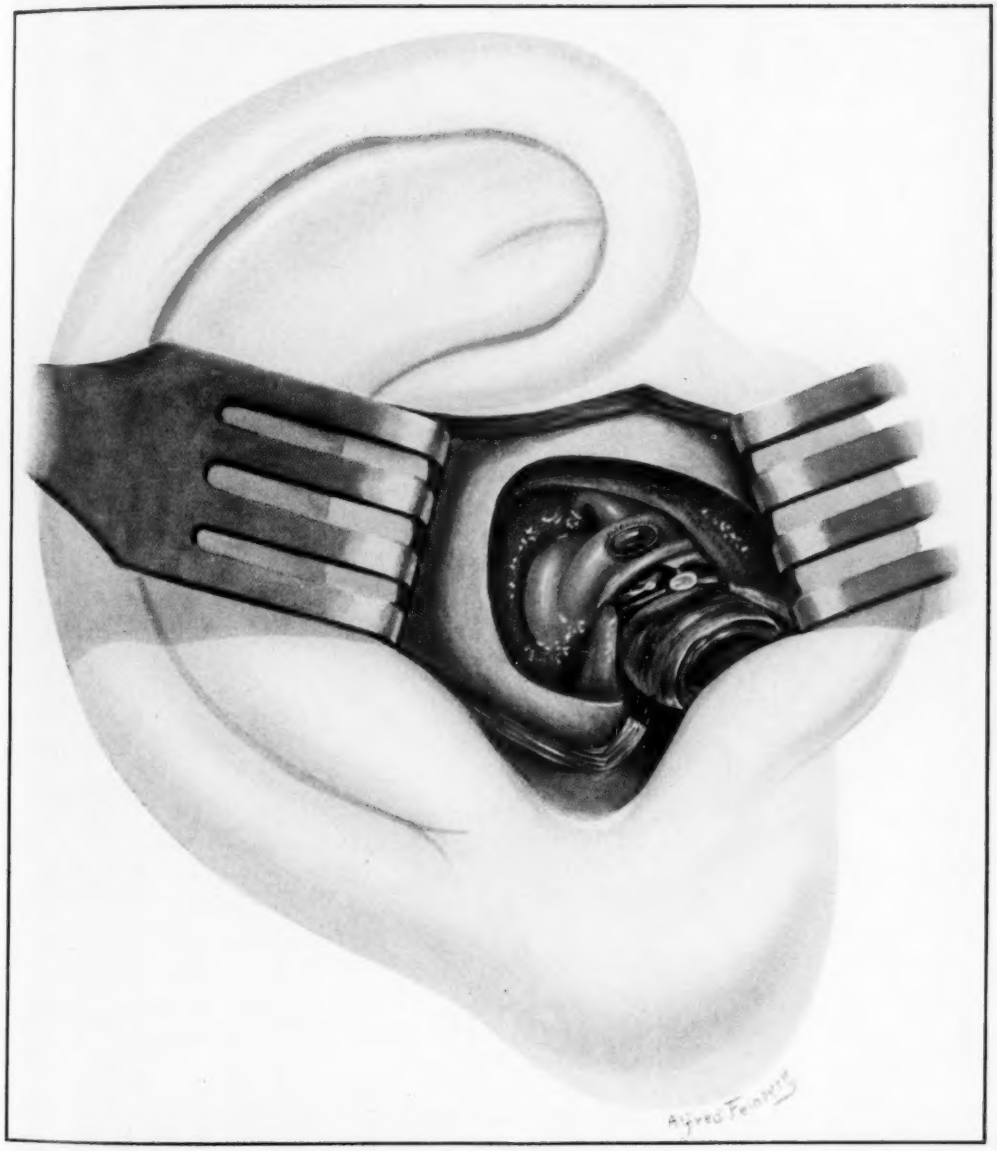

Fig. 10.—Step 4. The bony rim of the fenestra is burnished with lead.

A NEWER CONCEPT OF THE MANAGEMENT OF OTOGENIC INFECTION

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IN THE temperate zones otologic practice can be divided generally into two distinct seasonal phases. One is the summer phase, during which conditions are essentially the same both indoors and out as regards temperature and humidity. During the second, or winter, phase people live in different environments, the dry, warm indoors and the variable, cold outdoors. During this phase the human economy is subject to great fluctuations of temperature and humidity over relatively short periods. As a result, people have fall, winter and spring colds, with the ensuing complications, not the least of which are otogenic infections, such as otitis media and mastoiditis.

During the summer phase otologists see relatively few infections of this type but a greatly increased number of external otogenic infections. In addition, they frequently encounter exacerbations of chronic otogenic infections, which have been artificially activated by swimming, excessive sweating and bathing, with consequent pathologic aural changes.

If otogenic infections are studied bacteriologically, it will be found that the winter varieties are due predominately to gram-positive organisms. On the other hand, it has been noted by many observers that the primary infective agents in the external or summer type of otogenic infection are not the fungi or the gram-positive organisms but Pseudomonas aeruginosa (Bacillus pyocyaneus) or the Proteus group. Often in external otitis the infection is mixed, with both gram-negative and gram-positive organisms present. With the recent advance in chemotherapy and the use of antibiotics, otologists can show time and again how they can eliminate the gram-positive organisms and yet have the gram-negative ones flourish, their virulence unabated.

During the past five years we have observed a great many patients with otogenic diseases of all types. In their treatment we have been

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able to eliminate in a large measure the gram-positive organisms that cause morbidity. In six infections of the mastoid process treated surgically during the past five years, the infecting organism proved to be Ps. aeruginosa. In view of this, we searched for a substance which would be as effective against the gram-negative group of organisms as the sulfonamide drugs and penicillin are against the gram-positive group.

We shall apply our findings to three essential groups of otologic diseases: (1) acute otitis media, (2) chronic suppurative otitis media and (3) otitis externa.

By far the greatest number of patients treated for infections of the ears have acute otitis media. The infective agent has been variously reported as streptococci in 65 to 90 per cent, staphylococci in 5 to 15 per cent, pneumococci in 5 to 20 per cent and miscellaneous organisms in the remaining ones.[1] It is our belief that all pathologic conditions of ears are due initially to infections; that is, a micro-organism was necessary for the inception of each. This does not discount the fact that anatomic variations and altered physiology may well be a major contributing factor in preventing resolution. Nevertheless, if there were no infective agent, there would be extremely few pathologic ears.

If acute otitis media is diagnosed and treated early in its course with the now readily available armamentarium, resolution takes place within a month, and complications are few. In cases in which complications occur and in which the condition becomes chronic, we frequently note the presence of Ps. aeruginosa, against which the newer drugs are not effective. Initially these infections were probably due to the usual streptococci or staphylococci. However, a culture of material removed from an acutely inflamed ear which under adequate modern treatment persists in discharging for more than six weeks will almost always show a gram-negative organism.

Chronic suppuration of the ear always presents a problem, because so many pathologic factors may be involved, such as enlarged or diseased tubal lymphoid tissue, chronic infection of the eustachian tube, including stricture and granulation, polypoid tissue of the middle ear cavity and antrum, involvement of the ossicular chain, chronic infection of the membranous lining of the mastoid cells, bony necrosis and cholesteatomatous deposits.

For the treatment of these ears in which pathologic conditions have become chronic, whether the drum has been destroyed or perforated marginally or centrally, extreme cleanliness is a first prerequisite. The infection, as a rule, is deep seated, many cellular layers being involved. These can be treated adequately only with a substance that circulates

1. Kummel, W., in Kopetsky, S. J.: Otologic Surgery, ed. 2, New York, Paul B. Hoeber, 1929, p. 6. Woodward, F., in Jackson, C., and Jackson, C. L.: Diseases of the Ear, Nose and Throat, Philadelphia, W. B. Saunders Company, 1945, p. 282.

through the blood and lymphatic channels and thus reaches every part of the infective process. A medicament locally applied will not do that; its administration must be systemic. There is little question that with local cleansing and removal of excessive tubal tissue, granulation and polyps, many ears will cease discharging for varying periods, but the discharge will often recur. This may be related to the observation of Abraham and Chain [2] and Woodruff and Foster [3] that such gram-negative organisms as Ps. aeruginosa (B. pyocyaneus), coliform organisms and Proteus produce an enzyme, penicillinase, which destroys the property of bacteriostatic action in penicillin. To combat this, a group of antiseptics were employed which had proved to be active against the gram-negative bacteria, particularly those of the mucoid variety, such as Proteus and Ps. aeruginosa.

We have observed in our present study that local cleansing and systemic medication alone will often result in disappearance of the granulations and in cultures negative for gram-positive organisms but that in many cases the gram-negative forms remain and flourish.

The third variety of otogenic infection is external otitis, which has been shown by many observers [4] and by ourselves to be due predominately to the gram-negative Ps. aeruginosa. We feel that the concept of otitis externa has changed in recent years. In the past there has been overemphasis on the fungi as the etiologic agent.[5] The present work suggests Ps. aeruginosa as an important etiologic factor, which in the past was referred to only as the ubiquitous organism which overgrew many of the cultures. The pathogenicity of the organism was generally disregarded. It is our opinion, in light of not only this work but several recent surveys, that the fungi are relatively secondary in importance to Ps. aeruginosa.[6]

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2. Abraham, E. P., and Chain, E.: Enzyme from Bacteria Able to Destroy Penicillin, Nature, London **146**:837, 1940.

3. Woodruff, H., and Foster, L. W.: Microbiological Aspects of Penicillin, J. Bact. **49**:7, 1945.

4. Daggett, W. I.: Desquamative Otitis Externa in Malta, J. Laryng. & Otol. **57**:427, 1942. Davis, E. L.: Mycotic Ear Infections at an Advanced Allied Base, M. J. Australia **2**:437, 1943. Morley, G.: Otitis Externa: Hot Weather Ear, Brit. M. J. **1**:373, 1938.

5. Gill, W. D.: Mycotic Infections in Otolaryngology, South. M. J. **31**: 678, 1938; Otitis Externa, Ann. Otol., Rhin. & Laryng. **51**:370, 1942. Minchew, B. H.; Collins, B. E., and Harris, M. M.: External Ear Diseases with Special Reference to the Fungus Type, South. M. J. **33**:1345, 1940.

6. (*a*) Salvin, S. B., and Lewis, M. L.: External Otitis, with Additional Studies on the Genus Pseudomonas, J. Bact. **51**:495, 1946. (*b*) Senturia, B. H.: Etiology of External Otitis, Laryngoscope **55**:277, 1945. (*c*) Quayle, A. F.: Otitis Externus in New Guinea, M. J. Australia **2**:228, 1944. (*d*) Nelson, R. S.: External Otitis in the South Pacific, Ann. Otol., Rhin. & Laryng. **54**:367, 1945. (*e*) Syverton, J. T., and others: Otitis Externa, Arch. Otolaryng. **43**:213 (March) 1946.

The problem of otitis externa still remains a complicated one that frequently comes first to the attention of the dermatologist; later it may be referred to the otologist. In this study we have tried to group the cases according to type of otitis: diffuse, furuncular, eczematous and mycotic. Of course, one type often merges with another. Those grouped under the heading of otitis externa diffusa ranged from cases of severe cellulitis to cases in which the canals were chronically wet. Although this is generally considered an acute condition, in which the entire canal is inflamed and edematous, we included cases in which the condition was chronic, in many of which there were acute flare-ups. The cases in which typical "swimmers' ears" were observed fell into this category. Those cases with exfoliation and a tendency toward crusting and exudation, as well as cases of the dry scaling type, we termed "eczematous." Some were undoubtedly instances of seborrheic dermatitis, others were instances of impetigo and intertrigo, but they were all grouped under the heading of eczematous otitis.

As the study progressed, we were surprised to note the frequency of the presence of Ps. aeruginosa in ears whose diseases we had felt previously were probably due to fungous infections, and in those with chronic otitis media which had been under treatment. We noted also that only a few of these ears had the greenish pus commonly associated with B. pyocyaneus infections. Organisms isolated from these ears and placed in suitable artificial culture mediums did produce heavy pigmentation in many instances. Although we cultured material from only a few normal ears, our results confirm the findings of Syverton and associates [6e] and Salvin and Lewis [6a] in that Ps. aeruginosa rarely appeared in normal ears but did appear frequently in pathologic ears. Recent investigators, especially Salvin and Lewis,[6a] Syverton and associates [6e] and Williams and associates,[7] have seemed to corroborate this opinion.

In a group of 100 cases in which external otitis was medically treated, surveyed by Friedman and Hinkel,[8] those in which the involvement was acute, i. e., of less than one week's duration, presented little or no difficulty in treatment. In the group in which the disease was chronic, medical treatment failed in 72 per cent of the cases, and treatment was required for as long as six months in 19 per cent of the cases. Of cases in which external otitis was treated with roentgen rays, 36 per cent were listed as showing failure of treatment; in 20 per cent there were recurrences.

7. Williams, H. L.; Montgomery, H., and Powell, W. N.: Dermatitis of the Ear, J. A. M. A. **113**:641 (Aug. 19) 1939.

8. Friedman, H. S., and Hinkel, C. L.: External Otitis: A Study of the Comparative Merits of Medical and Roentgen Therapy, Arch. Otolaryng. **33**:749 (May) 1941.

In our study, material was taken from all ears after thorough cleansing of the conchae and outer auditory canal, but before treatment was instituted, for cultivation. The material was taken with a sterile applicator and streaked on blood agar plates. Sabouraud's medium and thioglycollate mediums were inoculated. Details of cultivation and isolation will not be discussed at length, but the results are shown in tables 1 through 4.

In our search for an agent that would be effective against gram-negative bacteria [9] and, in particular, against Ps. aeruginosa, many compounds were tried. The one found most satisfactory in the early part of this work was monobromosaligenin.[10] This substance, used in 5 per cent concentration in polyethylene glycol, proved to be effective against the gram-negative organisms. In the course of this study, dibromosalicylaldehyde [11] proved to be equally effective against the gram-negative organisms, and, in addition, active against fungi.

Dibromosalicylaldehyde is compared with similar fungistatic agents in table 5. It is about ten times as active as the proprietary compounds tested, containing sodium propionate and propionic acid or undecylenic acid and zinc undecylenate.

The antibiotic activity of dibromosalicylaldehyde was checked not only against gram-negative and gram-positive organisms (table 6) but also against the mixed cultures obtained in 6 of our cases (table 7).

PROCEDURE WITH DIBROMOSALICYLALDEHYDE

Dibromosalicylaldehyde, prepared in a 1.5 per cent sodium borate solution, was tested for antibacterial activity. Test tubes containing horse serum (1:10) in pork infusion broth were set up. Dilutions of dibromosalicylaldehyde ranging from 1:200 to 1:12,800 were made, and each was inoculated with a 4 mm. loop of a twenty-four hour culture of the test organism. This compound was tested against both gram-positive and gram-negative bacteria. Staphylococcus aureus 209 is the standard test strain of the department of agriculture. Streptococcus C-203 has been used in testing penicillin and the sulfonamide compounds. Ps. aeruginosa (B. pyocyaneus), Shigella dysenteriae (Shiga) and all the other organisms used in the test, other than those of the mixed cultures of this study, were taken from isolations made in the autopsy laboratory at the Johns Hopkins

9. Contact was made with Dr. John H. Brewer, director of biological research, Hynson, Westcott & Dunning, Baltimore, who was conducting a survey of compounds active against gram-negative organisms. Arrangements were made with him concerning the bacteriologic work and also concerning the several compounds discussed in this paper.

10. This is a preparation of monobromohydroxy, benzyl alcohol. It is marketed as "bromsalizol."

11. Dibromosalicylaldehyde is a light yellow crystalline compound, of which the empiric formula is $C_7 H_4 O_2 Br_2$. The molecular weight of the compound is 279-934 (hence the compound is called compound 280), and its melting point is 81 to 83 C.

TABLE 1.—*Otitis Externa*

Case	Duration	Clinical Type	Bacteriologic Findings	Length of Treatment	Comment
		A. Patients Treated Initially with Other Preparations and Then with Monobromosaligenin *			
1	5 days	Furuncular	Salmonella morgani	12 days	Resolved
2	6 mo.	Diffuse	Staphylococci, streptococci, diphtheroids	26 days	Resolved
3	6 mo.	Diffuse	Staphylococci, diphtheroids	30 days	Resolved
4	2 mo.	Diffuse	Yeast, E. coli, staphylococci, diphtheroids	14 days	Resolved
5	2 yr. recurrent	Diffuse	Ps. aeruginosa (B. pyocyaneus), staphylococci	15 days	Resolved
6	4 mo.	Diffuse	Ps. aeruginosa (B. pyocyaneus), E. coli, staphylococci, diphtheroids	23 days	Resolved
7	2 yr. in Persia	Eczematous	E. coli, beta streptococci, hemolytic staphylococci, diphtheroids	30 days	Resolved
8	4 days	Diffuse	Aerobacter aerogenes, S. morgani, staphylococci, diphtheroids	8 days	Resolved
9	5½ yr.	Diffuse	Ps. aeruginosa (B. pyocyaneus), staphylococci, diphtheroids	.....	.....
10	2 mo.	Diffuse	Aerobacter aerogenes, proteus, staphylococci, scarcinas	60 days	Resolved
11	6 weeks	Diffuse	Ps. aeruginosa (B. pyocyaneus), E. coli, staphylococci	2 weeks	Resolved
12	1 mo.	Diffuse	Ps. aeruginosa (B. pyocyaneus), hemolytic Staph. aureus	19 days	Resolved
13	4 yr.	Diffuse	Ps. aeruginosa (B. pyocyaneus), E. coli, staphylococci, gram-positive rods	6 days	Resolved
14	1 week	Diffuse	Ps. aeruginosa (B. pyocyaneus), paracolon bacilli, diphtheroids	21 days	Resolved
15	2 mo.	Diffuse	Ps. aeruginosa (B. pyocyaneus) E. coli, beta streptococci, staphylococci, diphtheroids, spore-former	3 days	Resolved
16	4 mo.	Eczematous	Ps. aeruginosa (B. pyocyaneus) beta streptococci	3 days	Resolved
17	2 weeks	Diffuse	Ps. aeruginosa (B. pyocyaneus), beta streptococci, Staph. albus, diphtheroids	8 days	Resolved
18	1 week	Diffuse	Both ears: Ps. aeruginosa (B. pyocyaneus), staphylococci, diphtheroids	7 days	Resolved
19	4 yr.	Diffuse	Ps. aeruginosa (B. pyocyaneus), alpha streptococci	8 days	Resolved
		B. Patients Treated with Monobromosaligenin Alone			
1	20 yr.	Diffuse	Beta streptococci, diphtheroids, proteus, yeast	14 days	Resolved
2	10 yr. recurrent	Eczematous	Staphylococci, Ps. aeruginosa (B. pyocyaneus)	14 days	Resolved
3	6 mo.	Diffuse	Ps. aeruginosa (B. pyocyaneus), A. aerogenes-E. coli group, staphylococci, diphtheroids	14 days	Resolved
4	2 weeks	Diffuse	Ps. aeruginosa (B. pyocyaneus), staphylococci	14 days	Resolved
5	1 week	Furuncular	Ps. aeruginosa (B. pyocyaneus), staphylococci	7 days	Resolved
6	9 mo.	Eczematous	A. aerogenes, staphylococci	1 day	No return
7	1 mo.	Diffuse	Ps. aeruginosa (B. pyocyaneus), gram-positive rods, staphylococci, streptococci	2 weeks	Resolved
8	2 weeks	Diffuse	Hemolytic staphylococci and streptococci, proteus	8 days	Resolved
9	1 mo.	Diffuse	Ps. aeruginosa (B. pyocyaneus), beta streptococci	6 days	Resolved

* This is known commercially as "bromsalizol."

TABLE 1.—*Otitis Externa—Continued*

Case	Duration	Clinical Type	Bacteriologic Findings	Length of Treatment	Comment
		B. Patients Treated with Monobromosaligenin Alone—Continued			
10	2 mo.	Diffuse	Ps. aeruginosa (B. pyocyaneus), hemolytic Staph. aureus	9 days	Resolved
11	2 yr.	Diffuse	Ps. aeruginosa (B. pyocyaneus), streptococci, diphtheroids, Staph. aureus	2 days	Resolved
12	2 yr.	Diffuse	Ps. aeruginosa (B. pyocyaneus), beta streptococci, Staph. aureus	7 days	Resolved
13	1 mo.	Diffuse	Paracolon bacilli, staphylococci	2 days	Resolved
14	22 mo.	Eczematous	Ps. aeruginosa (B. pyocyaneus), E. coli, staphylococci, streptococci, diphtheroids	2 days	Resolved
15	2 weeks	Diffuse	Nonlactose-fermenter, beta streptococci, hemolytic staphylococci, diphtheroids	5 days	Resolved
		C. Patients Treated with Dibromosalicylaldehyde			
1	2 weeks	Diffuse	Ps. aeruginosa (B. pyocyaneus), beta streptococci, staphylococci	7 days	Resolved
2	2 yr. recurrent	Mycotic	Fungi, staphylococci	16 days	Resolved
3	6 weeks	Diffuse, with excoriation	Ps. aeruginosa (B. pyocyaneus), A. aerogenes, gram-positive rods in chains, staphylococci, streptococci	21 days	Resolved
4	6 mo.	Diffuse	Ps. aeruginosa (B. pyocyaneus), staphylococci	7 days	Resolved
5	4 mo.	Mycotic	E. coli, Aspergillus niger	7 days	Resolved
6	2 weeks	Diffuse	Ps. aeruginosa (B. pyocyaneus), beta streptococci, hemolytic Staph. aureus	7 days	Resolved
7	3 yr.	Diffuse, with acute cellulitis for 2 weeks	Ps. aeruginosa (B. pyocyaneus), beta streptococci, hemolytic Staph. albus, diphtheroids	30 days	Resolved
8	1 week	Characterized by excoriative severe cellulitis (aspergillus isolated)	As. niger, Staph. albus, beta streptococci	14 days	Resolved
9	8 weeks	Characterized by exfoliative dermatitis	Ps. aeruginosa (B. pyocyaneus), beta and alpha streptococci, short gram-positive bacilli in pairs, hemolytic Staph. aureus	7 days	Resolved
10	2 weeks	Diffuse (green pus)	Ps. aeruginosa	3 days	Resolved
11	1 week	Diffuse	Ps. aeruginosa (B. pyocyaneus), A. aerogenes, alpha streptococci	.....	Resolved
12	1 mo.	Diffuse	E. coli–A. aerogenes group, hemolytic staphylococci, alpha and beta streptococci	7 days	Resolved
13	6 mo. recurrent	Diffuse	Ps. aeruginosa	3 days	Resolved
14	.....	Diffuse	Bacterium bronchisepticum	9 days	Resolved
15	2 yr. recurrent	Diffuse	Hemolytic Staph. aureus	14 days	Resolved
16	7 weeks	Diffuse	Ps. aeruginosa, E. coli–A. aerogenes group, Staph. albus, alpha streptococci	7 days	Resolved
17	7 weeks	Diffuse	Hemolytic Staph. aureus, beta streptococci, diphtheroids	1 day	Resolved
18	4 yr.	Diffuse	A. aerogenes, hemolytic Staph. albus	3 days	Resolved
19	3 weeks	Eczematous, with severe excoriation	E. coli, hemolytic Staph. albus, alpha streptococci	12 days	Resolved
20	6 mo.	Eczematous	Nonlactose-fermenter, beta streptococci, Staph. albus, diphtheroids	2 days	Resolved

TABLE 1.—*Otitis Externa—Continued*

Case	Duration	Clinical Type	Bacteriologic Findings	Length of Treatment	Comment
		C. Patients Treated with Dibromosalicylaldehyde—Continued			
21	4 mo. recurrent P. W.	Diffuse	Aspergillus (white), beta streptococci, Staph. albus Ps. aeruginosa	6 weeks periodic	Ps. aeruginosa persisted; patient did not return
22	3 mo.	Diffuse	A. aerogenes, hemolytic aerobic gram-positive rods	2 days	Resolved
23	6 weeks	Diffuse	Ps. aeruginosa, A. aerogenes, beta streptococci, diphtheroids	1 day	Resolved
24	2 weeks	Eczematous	Ps. aeruginosa, A. aerogenes, streptococci, staphylococci	3 days	Resolved
25	4 weeks	Diffuse	Gram-positive aerobic spore-forming bacilli, beta and alpha streptococci	2 days	Resolved
26	2 mo., twice recurrent in summer	Diffuse	Ps. aeruginosa (B. pyocyaneus)	3 days	Resolved
27	1 mo.	Diffuse	Ps. aeruginosa	7 days	Resolved
28	30 days	Diffuse	Alcaligenes faecalis, hemolytic Staph. aureus	14 days	Resolved
29	3 days	Furuncular	Ps. aeruginosa, beta streptococci, hemolytic Staph. albus	7 days	Resolved
30	3 yr.	Eczematoid	Ps. aeruginosa, penicillium, A. aerogenes, staphylococci, diphtheroids	30 days	Resolved
31	1 week	Furuncular	Proteus, gram-positive rods in chains (seen in thioglycollate broth), beta streptococci, diphtheroids	4 days	Resolved
32	3 weeks	Diffuse	Ps. aeruginosa, A. aerogenes, long thin gram-positive rods, staphylococci	6 days	Resolved
33	3 days	Furuncular	Hemolytic Staph. aureus, alpha streptococci	8 days	Resolved
34	8 days	Diffuse	Organism of E. coli–A. aerogenes group, diphtheroids	7 days	Resolved
35	14 days	Diffuse	Hemolytic Staph. aureus, diphtheroids	4 days	Resolved
36	6 mo., recurrent	Eczematous	Ps. aeruginosa, alpha streptococci, staphylococci	6 days	Resolved
37	4 mo.	Furuncular	Ps. aeruginosa	6 days	

Hospital. All tubes were incubated twenty-four hours at 37 C. and then read. Cup-plates prepared according to the standard Food and Drug Administration technic were set up to show the millimeters of inhibition of the mixed cultures obtained by cultivation of material taken from soldiers' ears.

TREATMENT

Depending on the result of the bacteriologic study, treatment was instituted as follows:

1. The patients who had chronically suppurative ears with cultures of predominantly gram-positive organisms were given 20,000 units of penicillin intramuscularly every three hours until the gram-positive organisms disappeared from the culture or the ear was dry. In many cases the gram-positive organisms disappeared and the gram-negative organisms, especially Ps. aeruginosa, flourished. In these cases the

ears were cleansed and irrigated with a 1 per cent solution of dibromosalicylaldehyde once or twice daily, followed by insufflation of a powder consisting of dibromosalicylaldehyde (2 per cent), sodium borate (3 per cent) and talcum (95 per cent).

2. Treatment was instituted in cases of otitis externa immediately after the initial culture was obtained. In all of such cases, regardless of the type of otitis, the ears are cleansed as thoroughly as possible,

TABLE 2.—*Chronic Otitis Media*

Case	Duration	Clinical Type	Bacteriologic Findings	Length of Treatment	Comment
			A. Patients Treated with Sulfadiazine or Penicillin and Then with Insufflation of Dibromosalicylaldehyde Powder		
1	15 yr.	.....	Ps. aeruginosa, staphylococci, streptococci, diphtheroids	16 days	Dry
2	8 yr. recurrent, present attack 1 mo.	.....	Paratyphoid B organisms, S. morgani, staphylococci	5 days	Dry
3	33 yr.	.....	Ps. aeruginosa, hemolytic Staph. aureus, beta streptococci	40 days	Dry
4	10 yr.	.....	Hemolytic Staph. aureus, diphtheroids	2 weeks	Dry
5	5 mo.	.....	Proteus, E. coli, Ps. aeruginosa, beta and alpha streptococci	30 days	Dry
			B. Patients Treated with Sulfadiazine and Penicillin		
1	20 yr.	.....	Organism of E. coli-A. aerogenes group, staphylococci, gram-positive spore-former	30 days	Improved
2	15 yr.	.....	Ps. aeruginosa, staphylococci	30 days	Improved
3	20 yr.	.....	E. coli, proteus, beta and alpha streptococci, staphylococci, diphtheroids	30 days	Improved
			C. Patients Treated with Insufflation of Dibromosalicylaldehyde Alone		
1	12 mo.	.....	Ps. aeruginosa, beta streptococci, staphylococci	1 week	Dry
2	1 yr.	.....	Gram-negative (Salmonella), beta streptococci, diphtheroids	4 days	Dry
3	8 mo.	.....	Ps. aeruginosa, A. aerogenes, staphylococci, streptococci	5 days	Dry
4	6 yr.	Radical cav.	Ps. aeruginosa	14 days	Dry
5	4 yr.	Radical cav.	Ps. aeruginosa, alpha streptococci	4 days	Dry

the degree depending on the amount of cellulitis. In cases of otitis externa diffusa, a wick of ¼ inch (6.5 mm.) gauze saturated with "carbowax" [12] containing dibromosalicylaldehyde in concentration of 2 per cent is introduced into the canal. This may remain twenty-four to seventy-two hours. Occasionally the patient will complain of a burning sensation, which may persist for as long as three hours. This procedure is repeated and another wick inserted if the clinical appearance

12. The "carbowax" compounds are polyethylene glycols of high molecular weight.

TABLE 3.—*Chronic Otitis Media Complicated by External Otitis*

Case	Duration	Bacteriologic Findings	Length of Treatment	Comment
A. Treated with Penicillin and/or Sulfadiazine and then with Dibromosalicylaldehyde				
1	4 yr.	Hemolytic staphylococci	28 days	Improved
2	16 yr.	Ps. aeruginosa, staphylococci, beta streptococci	.....	.....
3	35 yr.	Ps. aeruginosa, A. aerogenes, beta streptococci, staphylococci	14 days	Canal improved but ear not dry
4	6 mo.	Ps. aeruginosa, Staph. aureus, streptococci, E. coli	75 days	Dry
5	20 yr.	Ps. aeruginosa, staphylococci	20 days	Improved
6	4 yr.	Ps. aeruginosa, alpha and beta streptococci, staphylococci	30 days	Drum healed, canal clear
7	20 yr.	Ps. aeruginosa, A. aerogenes, staphylococci, diphtheroids	30 days	Dry
8	25 yr.	Ps. aeruginosa, hemolytic staphylococci, streptococci	30 days	Improved
9	26 yr.	Ps. aeruginosa, Staph. aureus, alpha streptococci	14 days	Dry
10	20 days	Staphylococci, diphtheroids	16 days	Dry
B. Patients Treated with Dibromosalicylaldehyde Alone				
1	8 yr.	Ps. aeruginosa, gram-positive aerobic spore-former, staphylococci	15 days	Dry
2	20 yr.	Ps. aeruginosa, staphylococci, beta streptococci	4 mo.	Dry
3	4 yr.	Ps. aeruginosa, staphylococci	10 days	Dry
4	2 yr.	S. morgani, staphylococci	5 days	Not followed
5	19 yr.	Hemolytic Staph. aureus, diphtheroids	5 days	Dry

TABLE 4.—*Normal Ears*

Case	Bacteriologic Findings
1	Hemolytic staphylococci, beta streptococci
2	Gram-positive cocci
3	Hemolytic Staph. aureus
4	Paracolon bacilli, staphylococci

TABLE 5.—*Cup-Plate Test with Five Million Spores of Trichophyton Mentagrophytes* *

Compound	Inhibition in Given Dilution, Mm.*				
	1:20	1:200	1:2,000	1:20,000	1:200,000
Dibromosalicylaldehyde	Complete	23 mm.	10 mm.	8 mm.	—
Dibromosalicylaldehyde †	1:50 Complete	28 mm.	11 mm.	Trace	—
Zinc undecylenate and undecylenic acid	1:18 15 mm.	12 mm.	6 mm.	Trace	—
Propionic acid and sodium propionate	1:5 20 mm.	—	—	—	—
Monobromosaligenin	20 mm.	2 mm.	—	—	—

* The technic is that described by Emmonds (Am. J. Pub. Health **35**: 844 [Aug.] 1945).
† The bisulfite form was used.

suggests further treatment; often one wick is sufficient. In cases of the eczematous type, treatment consists either of insertion of a wick or a simple twenty-four hours local application, followed by cleansing with dry wipes and insufflation of the dibromosalicylaldehyde powder. The powder may be insufflated at daily to weekly intervals, depending

TABLE 6.—*Antibiotic Activity of Dibromosalicylaldehyde Shown in Dilutions of 10 per Cent Horse Serum Infusion Broth*

	Dilutions of Dibromosalicylaldehyde						
Gram-Positive Test Organism	1:1,000	1:2,000	1:4,000	1:8,000	1:16,000	1:32,000	1:64,000
Staphylococcus aureus (209).....	—	—	—	+	++++	++++	++++
Streptococcus (C-203).....	—	—	—	±	++++	++++	++++

	Dilutions of Dibromosalicylaldehyde				
Gram-Negative Test Organism	1:800	1:1,600	1:3,200	1:6,400	1:12,800
Escherichia coli.....	—	—	—	—	+
Proteus.....	—	—	—	+	+++
Aerobacter aerogenes.....	—	±	+	++	+++
Pseudomonas aeruginosa (B. pyocyaneus).	—	Pellicle	+	++	+++
Shigella dysenteriae (Shiga).....	—	—	—	±	+
Friedländer's bacillus.....	—	+	++	+++	++++

TABLE 7.—*Antibiotic Activity of Dibromosalicylaldehyde Tested in 10 per Cent Horse Serum Infusion Broth Against Mixed Cultures in 6 Cases*

	Dibromosalicylaldehyde (1%), Duponol (1%) and Sodium Borate (1.5%)						Cup-Plate Containing Dibromo-salicylaldehyde (1%)
Case	1:200	1:400	1:800	1:1,600	1:3,200	1:6,400	
21 (table 1, part C)	—	—	Pellicle ++	++++	++++	++++	Ring shadow of 5 mm. in 24 hr.; no true inhibition
28 (table 1, part C)	—	—	Pellicle +	++	++++	++++	5 mm. of complete inhibition
29 (table 1, part C)	—	—	+	Pellicle +++	++++	++++	
2 (table 4).....	—	—	+	Pellicle +++	++++	++++	Less than 1 mm. of complete inhibition
30 (table 1, part C)	—	—	++	Pellicle ++++	++++	++++	Slight trace of inhibition
3 (table 4).....	—	—	++	+++	Flocculent sediment ++++	++++	

on the appearance of the lesions. In those cases in which there may be simply slight weeping, insufflation will suffice. In this study a case of sensitivity to dibromosalicylaldehyde was encountered. The reaction was that of a complicating contact dermatitis. In subsequent observations, not included in this group, another case of sensitivity was encountered.

Of the 71 cases of external otitis studied (table 1), 42 revealed the presence of Ps. aeruginosa; in the remainder, gram-negative organisms

were usually present. The exceptions were the 2 cases of otomycosis. Only 21 of the 71 cases were of less than three weeks' duration, and in these the otitis responded readily to use of either the original monobromosaligenin or dibromosalicylaldehyde. Even without the initial cleansing of the canal the response to the treatment proved satisfactory. In these cases, for the most part the infection resolved in less than one week. Relief of symptoms often occurred in less than twenty-four hours.

There were 50 cases of chronic external otitis. In many the process was the recurrent type, lasting up to twenty years. In 30 cases the

TABLE 8.—*Antibiotic Activity of Monobromosaligenin Against Both Gram-Negative and Gram-Positive Organisms*

		Dilutions of 0.5% Monobromosaligenin plus 1 Cc. of Horse Serum Inoculated with 1 Loop (4 Mm.) of 24 Hr. Culture					
Gram-Negative Organism	Date	1:400	1:800	1:1,000	1:1,200	1:1,600	1:3,200
Shigella sonne	10/5/45	—	—	++	++++	++++	++++
Shigella paradysenteriae (Flexner)	10/5/45	—	—	Flocculent Sediment ++++	++++	++++	++++
Shigella dysenteriae (Shiga)	10/5/45	—	—	++	++++	++++	++++
Shigella ambigua	10/5/45	—	—	++++	++++	++++	++++
Shigella gallinarum	10/5/45	—	—	+	Flocculent Sediment ++++	++++	++++
Proteus vulgaris	10/5/45	—	++	++++	Flocculent Sediment ++++	++++	++++
Salmonella typhimurium Ea	10/5/45	—	—	++	++++	++++	++++
Eberthella typhosa (Rawlings)	10/5/45	—	—	+	++	++++	++++
Pseudomonas aeruginosa	10/5/45	—	++	++++	++++	++++	++++

		Dilutions of 0.5% Monobromosaligenin Inoculated with 1 Loop (4 Mm.) of 24 Hr. Culture *				
Gram-Positive Organism	Date	1:200	1:400	1:800	1:1,600	1:3,200
Staphylococcus aureus (209) no serum	9/22/45	—	—	—	++	++++
Streptococcus (C-203) with serum	9/22/45	—	—	—	++	++++

* Marked irregularity was noted in almost every tube of growth. Floaters and precipitate were seen instead of the usual characteristic smooth growth. The results were read at twenty-four hours.

infection resolved in one week or less; in the remainder the ear required two to four weeks' treatment. Two patients failed to return, and 1 patient was seen at infrequent intervals and was classified as a failure. Ten cases were checked bacteriologically after thirty days and the cultures found to be negative. Only 3 patients were seen after six months, although many were followed up to three months. Subsequent follow-up was not possible. With the exception of a case of seborrheic dermatitis, no recurrences were seen. In this case only the local auricular lesion was treated, and it responded promptly.

In the treatment of otitis externa, dibromosalicylaldehyde gave more rapid alleviation of symptoms and final resolution than the original monobromosaligenin.

This study included 28 cases of otitis media (tables 2 and 3). With little regard to underlying foci or extent of lesion, the patients were treated systemically or locally, as indicated in tables 2 and 3. It is again interesting to note that in 17 of these 28 cases the presence of Ps. aeruginosa was discovered, and that only 4 cases suggested that we were dealing with a gram-positive organism as an etiologic agent. In many instances, however, penicillin or sulfadiazine had been used before a culture was obtained. Twelve of the treated ears became dry in less than two weeks, and 6 of these had insufflation of dibromosalicylaldehyde alone. Two cavities resulting from radical mastoidectomies cleared up in less than two weeks. In a case of chronic otitis media of four years' duration, complicated by external otitis, complete resolution, with healing of the drum, occurred. In the remainder of the cases treatment was required for periods ranging up to two and a half months. In 8 of these the ear did not become dry and the patient was separated from the army.

SUMMARY

In the temperate zone otogenic infections are essentially of two types: a winter type, infections due to gram-positive organisms, and a summer type, infections due to gram-negative organisms.

The type caused by gram-positive organisms can be treated adequately with the sulfonamide drugs and the antibiotics. The type characterized by gram-negative organisms does not respond to these drugs.

One hundred cases were studied clinically and bacteriologically (160 cultures).

It was found that the resistant etiologic agent in chronic suppurative otitis media and external otitis was predominantly Pseudomonas aeruginosa (Bacillus pyocyaneus).

A new compound, dibromosalicylaldehyde, proved to be especially effective against gram-negative organisms, including Pseudomonas, and also against fungi.

Dibromosalicylaldehyde can be utilized in powder, ointment and solution.

Seventy-one patients with external otitis were relieved of symptoms within twenty-four hours. In 30 the infection resolved in one week or less, and the rest required two to four weeks' treatment. Three cases were classified as failures because the patients failed to return for treatment. Although follow-up was inadequate, only 1 patient returned with a recurrence; this one had seborrheic dermatitis.

Of 28 patients who had otitis media, 12 had dry ears in two to six weeks; the remainder required up to two and a half months' treatment. Only in 8 did the ears fail to become dry.

In our cases, dibromosalicylaldehyde proved to be an effective agent in the treatment of ears infected with gram-negative bacteria and fungi.

COMMENT AND CONCLUSION

This study was begun in 1941, before attention had been drawn to the fact that Pseudomonas aeruginosa is an important etiologic factor in chronic infections of the ear. It was this observation which led us to search for a chemical agent that would be more effective against this type of persistent infection. In a carefully controlled bacteriologic and clinical study of 100 cases of otitic infections, a new chemical agent, dibromosalicylaldehyde, has been found more satisfactory than other agents suggested thus far. Owing to the unavailability of streptomycin, no opportunity has been afforded to study the efficacy of this antibiotic in these types of aural infections. Dibromosalicylaldehyde ("dalyde") is a readily available, inexpensive chemical agent, which is effective against both bacteria and fungi.

Dr. Lloyd C. Felton prepared the compounds and the various solutions employed in this study; Miss Beatrice Day aided in isolating the organisms from the pathologic aural canals. Most of the clinical work was conducted under the supervision of Col. Harry A. Clark, Medical Corps, United States Army, and Sgt. Thomas Pilon was of assistance in the technical management of the study.

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LOSS OF SPEECH DUE TO MENINGITIC DEAFNESS

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DURING the past three years I have had the privilege of studying 29 cases of total deafness due to meningitis. None of the patients gave a history of deafness occurring in the family. I am convinced that all of them had normal hearing at the inception of their meningitis. With the exception of the 3 patients who had meningitis before the age of 12 months, they all had speech normal for their age. The primary purpose of this paper is to study the changes occurring in the speech of such patients. Therefore, I have eliminated all cases in which there was more than residual hearing. By residual hearing, I mean no better hearing than that indicated by a 75 decibel loss up to 500 cycles per second and no response above this frequency.

The literature on this subject is meager. The reason lies in the fact that until the antibiotics began to be used universally in the treatment of meningitis most patients of the type considered did not survive. In 1933 Shambaugh, Wallner, Greene and Shambaugh [1] reported an exhaustive survey of 5,000 children in institutions for the deaf, in which they found 20 per cent with deafness due to meningitis. From my own experience I venture that few of those children were totally deafened. In 1945 Degen and associates [2] reported a survey of 986 cases of cerebrospinal meningitis in England among which there were 27 cases in which total deafness resulted, or 2.7 per cent. In 3 of these 27 cases there was subsequently some recovery of hearing. I have seen 2 patients in whom I felt there was no hearing after their recovery from meningitis but who in from six to eighteen months showed evidence of some hearing. These 2 cases are not included in my series.

In table 1 I have listed these cases with the ages and the vocabularies of the patients as noted when they became deafened; also, the periods elapsed from the times at which the patients recovered from meningitis until voice changes were noticed, and the periods elapsed until there was total loss of speech. It will be noticed that the age incidence is from 10

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1. Shambaugh, G. E.; Wallner, L. J.; Greene, L. D., and Shambaugh, G. E., Jr.: Severe Deafness in Adults, Arch. Otolaryng. **18**:430-448 (Oct.) 1933.

2. Degen, J., and others: Sequelae of Cerebrospinal Meningitis: Follow-Up Study of Nine Hundred Eighty-Six Cases, Brit. M. J. **2**:243-247 (Aug. 25) 1945.

months to 26 years; however, 19 of the patients had meningitis within the first three years of life.

Eight of the 10 youngest children regained consciousness without speech, although 5 of these 8 had a definite vocabulary of from 5 to 10 words before their illness. The two exceptions are nos. 8 and 10, and it is to be noted that both of these had a better than average vocabulary for their age. The next 5 older children had a distinct voice change when they became conscious, and all of these had lost their speech within eight

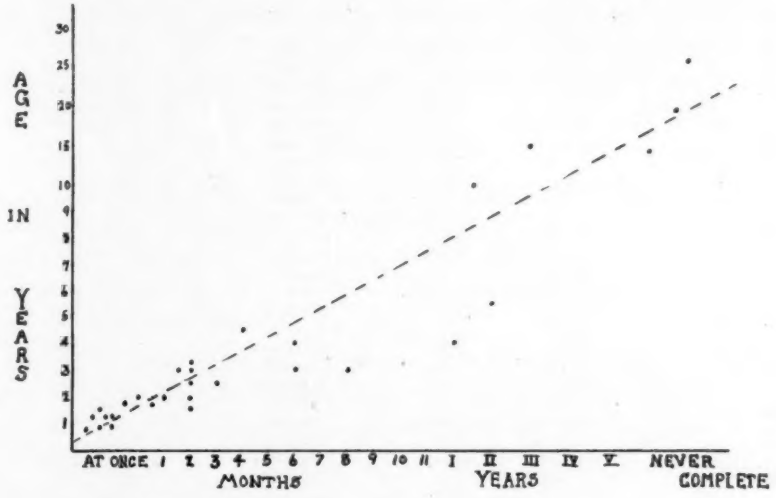
TABLE 1.—*Age at Which Meningitis Occurred, Extent of the Vocabulary, Time at Which Voice Change Was Noted with Reference to Recovery from Meningitis and Time at Which Loss of Speech was Complete with Reference to Recovery*

Case	Meningitis	Words	Voice Change	Loss of Speech
1	7 mo.	None	At once	At once
2	10 mo.	None	At once	At once
3	11 mo.	None	At once	At once
4	14 mo.	5	At once	At once
5	14 mo.	5	At once	At once
6	16 mo.	10	At once	At once
7	18 mo.	10	At once	At once
8	18 mo.	20	3 weeks later	8 weeks later
9	20 mo.	10	At once	At once
10	20 mo.	20	At once	3 weeks later
11	2 yr.	30	At once	10 days later
12	2 yr.	30	At once	4 weeks later
13	2 yr.	50	At once	8 weeks later
14	2½ yr.	Many	At once	8 weeks later
15	2½ yr.	Many	3 weeks later	3 mo. later
16	3 yr.	30	2 weeks later	6 weeks later
17	3 yr.	Many	3 weeks later	6 weeks later
18	3 yr.	Many	2 mo. later	6 mo. later
19	3 yr.	Many	2 mo. later	8 mo. later
20	3¼ yr.	Many	4 weeks later	8 weeks later
21	4 yr.	Many	3 mo. later	6 mo. later
22	4 yr.	Many	4 weeks later	1 yr. later
23	4½ yr.	Many	2 weeks later	4 mo. later
24	6 yr.	Many	6 mo. later	2 yr. later
25	10 yr.	Many	3 mo. later	18 mo. later
26	14 yr.	Many	3 mo. later	Never
27	18 yr.	Many	1 yr. later	3 yr. later
28	19 yr.	Many	1 yr. later	Never
29	26 yr.	Many	3 yr. later	Never

weeks. Three of the 4 oldest persons never lost their speech completely. In case 27 the patient had a gradual loss of speech, starting about one year after his recovery, until 3 years later, when he became speechless. In this case I am sure that there was a large psychogenic factor in the patient's becoming speechless, because it was eight months after speech training had been started before he began to speak.

The time elapsing between recovery from meningitis and loss of speech follows a rather definite pattern, as shown in the chart. I have plotted these 29 cases according to the age at which deafness was acquired, along the vertical axis, and according to the time elapsed before they became speechless, along the horizontal axis. The broken line represents a bisection of the average of these two factors.

In table 2 I have listed the ages at which the patients had meningitis, the ages at which speech training was started and the present estimates of their speech. These evaluations were arrived at by combining the opinions of three persons, namely, the child's mother, the teacher and myself. In studying this table, one notices that there are 13 cases in which speech was classified as either very good or good. The patient in case 29 had meningitis at the age of 26 years and never lost her speech. In the remaining 12 cases so classified the average length of time between recovery and the starting of speech training was seventeen months. In the 9 cases in which speech was classified as fairly good or fair, this average time was twenty-seven months. In the 4 cases in which



Loss of speech plotted with reference to age of patient and time after recovery from meningitis.

speech was classified as poor or very poor, the average time was thirty-three months. Of course, the length of time that the patient had training alters these figures to some extent, but in general it is apparent that the quicker such patients are started on speech training the better the end result.

It has been interesting to study the bacteria involved in producing total deafness in these 29 cases. I was able to ascertain the causative organism accurately in 21 cases. In 15 cases the condition was due to meningococci; in 3, to Hemophilus influenzae; in 2, to pneumococci; and in 1 case, to beta streptococci. The 2 patients previously referred to, in whom total loss of hearing immediately followed the meningitis but who subsequently showed some recovery of hearing, had influenzal menin-

gitis. In 1937 Eagleton [3] reported that pyogenic meningitis was usually confined to the arachnoid, and any resulting deafness was seldom complete. He also stated that deafness following meningococcic meningitis was nearly always complete because the disease involved the blood vessels of the nerves. Although I cannot speak about the micropathologic changes in my series of cases, the clinical picture certainly tends to confirm Eagleton's work.

Now, I should like to report on one of the most fascinating parts of this study. The account is in the form of a preliminary report, because

TABLE 2.—*Age at Which Meningitis Occurred, Age at Which Speech Training was Started, and Status of Speech at the Age Given*

Case	Meningitis	Training Started	Speech at	
1	7 mo.	4 years	6	Fair
2	10 mo.	4 years	4	None
3	11 mo.	5 years	10	Very poor
4	14 mo.	6 years	16	Fairly good
5	14 mo.	3 years	4	Very poor
6	16 mo.	4 years	17	Good
7	18 mo.	3 years	8	Fairly good
8	18 mo.	4 years	6	Fair
9	20 mo.	3 years	11	Very good
10	20 mo.	2 years	3	Poor
11	2 yr.	5 years	6	Poor
12	2 yr.	4 years	4	None
13	2 yr.	5 years	16	Very good
14	2½ yr.	4 years	10	Fairly good
15	2½ yr.	3 years	4	None
16	3 yr.	6 years	16	Good
17	3 yr.	At once	5	Fairly good
18	3 yr.	8 years	21	Good
19	3 yr.	4 years	5	Fair
20	3¼ yr.	4 years	7	Good
21	4 yr.	At once	5	Good
22	4 yr.	5 years	13	Good
23	4½ yr.	6 years	7	Fairly good
24	6 yr.	7 years	9	Fair
25	10 yr.	11 years	12	Good
26	14 yr.	15 years	16	Good
27	18 yr.	21 years	26	Good
28	19 yr.	20 years	48	Good
29	26 yr.	Never	55	Good

many of the problems are yet to be solved. After the fifth pair of parents voluntarily said that they were positive that their child could hear an airplane in the sky, I became much interested. I investigated 3 of the 5 children with respect to this idea, and I am thoroughly convinced that they could appreciate without other warning a two motor airplane flying as high as one mile (1.5 kilometers) in the air. With but one exception, the 21 youngest children in this series all seemed to have this ability. In 17 cases this information was volunteered without my having asked a question about it.

3. Eagleton, W. P.: Suggestions for Prevention of Ocular and Aural Sequelae of Meningococcic Meningitis, Arch. Ophth. **18**:46-49 (July) 1937.

Eight of these 20 children were tested with frequencies of from 10,000 to 30,000 cycles per second but seemed to show no response. I was able to study 2 of the 3 children investigated by myself as to their response to twin-engined airplanes with the motors going but not in flight. Further questioning of the other parents convinced me that these airplanes must be twin engined and in flight. After presenting this problem to several eminent acoustic physicists, I received from Mr. Frank Massa, Cleveland, what may be the correct answer. He thinks that it is a combination of Doppler's phenomenon and the beat phenomenon of 2 synchronized airplane motors. The resultant is a frequency of somewhere around 20 cycles per second with fairly high intensity that is appreciated by these children but not by a normally hearing ear. This idea is still being investigated, particularly in studying how the early speech training of such deafened children may be augmented. So far, we have been unable to demonstrate this phenomenon in congenitally deafened children.

CONCLUSIONS

1. In cases of total deafness due to meningitis the loss of speech follows a fairly definite pattern, which can be stated as follows: When a person with normal hearing and normal speech becomes totally deaf, he tends to lose his speech to an extent directly proportional to the length of time that he had speech.

2. It is important that speech training be started at once in these cases. This is particularly true with regard to the younger patients, because their memory patterns are not firmly established.

3. Meningococcic meningitis is more likely to produce total deafness than meningitis caused by other types of bacteria.

4. Many of these deafened children have an appreciation of a flying two motor airplane even though all other hearing sensations have gone. This phenomenon is possibly due to subsonic vibrations and may lead to the development of improved methods of speech training for deafened children.

10515 Carnegie Avenue.

DISCUSSION

DR. DOUGLAS MACFARLAN, Philadelphia: Dr. Kinney undertakes a consideration of the most important situation that arises in cases of meningitis after the subsidence of the acute attack, that is, loss of speech.

All should realize how soon speech is lost in these cases, and how hard it is to regain speech or to correct distorted speech. Much depends on the age at which the meningitis strikes, for those with the longest experience of speech and language will show the slower onset of speech damage. That was one of the conclusions which Dr. Kinney mentioned.

Children of 2 and 3 years of age must be put under a trained teacher of the deaf immediately. One should not allow even a period of convalescence without daily practice of speech.

I regret to differ with Dr. Kinney and others whom he quotes as to total deafness in cases of meningitis. He believes that few of the patients are totally deaf. I believe it is rare to find any usable residual hearing. I have found only 3 cases in which there was a remnant, and in those there was not enough to warrant the use of amplified sound. Careful testing will show that many of the patients will report a tactile sensation for hearing, and a tactile sensation will appear at the middle frequencies as low as 80 decibels of loudness. One can and should test to discriminate between the reporting of feeling and what is truly hearing.

The child is trained in a conditioned response and is then tested with an audiometer. Here is such a conditioned response trainer, which I will demonstrate to any one interested. It depends on using a sound loud enough to reach the child's tactile sense. When the instrument is being turned on, the child can be trained to raise the hand to a tactile vibration. Once trained to respond correctly, if he still responds when the machine is attenuated down below the point at which it stimulates the tactile sense he must be reporting as hearing. My associates and I use it because the little deaf child is prone to succumb to complete auditory negation, and attention must be acoustically retrained. Another method to use for children who are profoundly deaf is a sweep type oscillator with an intensity control. If the child truly hears sounds, he will report correctly when a pitch is raised or lowered. Few otologists have such oscillators, so that the best that one can do is to have the child imitate the pitch by humming or whistling.

Remember that audition and the tactile sense overlap at high intensities in the middle range. Remember that children deaf before they acquire language, 2 years old (8 of Dr. Kinney's 29 patients were in this class), do not present the same problem as the child who has some language and memory of speech. More progress can be made in the latter group. If there is usable hearing in either group, a hearing aid must be put on, and memories of sounds built up and maintained.

But most of the patients deaf as a result of meningitis have no usable hearing, and the kinesthetic method must be used to maintain and train speech. Equally important in these cases are the problems of adjustment. Most people who work with the deaf find that these children simply will not adjust to a school routine. Their behavior problems are many and often exaggerated. Among twenty-seven characteristics listed by Louttit [4] as sequelae of meningitis the following are conspicuous: malicious mischief, assaultiveness, lack of inhibition, impulsiveness, indifference, impudence, dominating demeanor, restlessness and inability to accept discipline. Their behavior, Myklebust [5] believes, is due to primary damage of the nervous system rather than destruction of the inner ear: "It seems probable that the higher nerve centers are affected." Thus the behavior problem is practically as important as the speech problem if one is going to make the child fit into this society.

Here, then, is another reason why the child deaf as a result of meningitis should be placed immediately under a trained teacher of the deaf. Otherwise behavior problems will develop as rapidly as will speech disorders.

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4. Louttit, C. M.: Clinical Psychology, New York, Harper & Brothers, 1936; cited by Myklebust.[5]

5. Myklebust, H. R.: Am. J. Psychol. **59**:249 (April) 1946.

As to the speech damages following meningitis in adults, the cases seem to follow no rhyme or reason, and are much like the acquired total nerve deafness seen in the veterans' hospitals. In some cases speech changes appear early and are profound and intractable. In other cases speech does not deteriorate greatly.

All have had the same experience with chronic progressive deafness that has gone on to total loss of serviceable hearing. In some of the patients speech is changed. In others, just as deaf, speech remains unchanged. It apparently is not a matter of residual bone conduction, for each group is equally deficient in bone conduction, as they do not hear their own voices. No one has given the explanation of this.

Finally, again remember Dr. Kinney's warning: Get the child under training immediately.

OTOSCLEROSIS

An Index of the Literature, with Abstracts, for 1946

THIS is the third instalment of volume IV of "Otosclerosis" to be issued by the Central Bureau of Research of the American Otological Society, Inc.[1] Several foreign articles and others heretofore unobtainable are listed or abstracted herein. Research on correlated subjects, especially if encouraged or supported in whole or in part by the Bureau, will also be included.

In all instances the opinions of the authors are quoted without comment, and the selection of articles implies no endorsement or condemnation thereof. All titles are given in English and the names of all mediums of publication in the language of the original. Dr. Franz Altmann has continued to prepare the translations and outline the abstracts.

Our desire is to publish each year's installment before the end of the following year, but unavoidable delays have made this impossible for 1946.

This instalment, with index of authors according to subjects and perforated for loose-leaf binding in volume IV of "Otosclerosis," may be obtained at cost ($1.00) from

EDMUND PRINCE FOWLER, M.D., *Editor*
140 East Fifty-Fourth Street, New York 22.

1. The Central Bureau of Research (originally the Committee on Otosclerosis) of the American Otological Society, Inc., is constituted as follows: Board of Trustees of the Research Fund: D. Harold Walker, M.D., chairman, Boston; John R. Page, M.D., vice chairman, New York; Edmund Prince Fowler, M.D., secretary, New York; Wesley C. Bowers, M.D., New York; Marvin F. Jones, M.D., New York; J. Gordon Wilson, M.D., Chicago; D. E. Staunton Wishart, M.D., Toronto, Canada. Lay Advisors to the Board: E. Ericson, New York; Samuel Lloyd, New York. Consultants to the Board: Madison Bentley, Ph.D., LL.D., professor of psychology emeritus, Cornell University; J. B. Collip, M.D., D.Sc., F.R.C.P., F.R.S., professor of medical research, University of Western Ontario; Stacy R. Guild, Ph.D., Johns Hopkins University; Oscar Riddle, Ph.D., LL.D., D.H.C., Plant City, Fla.; Philip E. Smith, Ph.D., professor of anatomy, College of Physicians and Surgeons, Columbia University. Treasurer: Walter C. Baker. Depositary: Guaranty Trust Company of New York. Office of the Secretary: 140 East Fifty-Fourth Street, New York 22.

LITERATURE UNOBTAINABLE AND NOT LISTED IN PREVIOUS INSTALMENTS

Nielsen, H. E. Familial Occurrence of Osseous Fragility, Blue Sclera and Deafness, *Nord. med.* (*Hospitalstid.*) **15:** 2203, 1942.

de Gunten, P. Is It Possible to Cure Otosclerosis with A. T. 10 (Results of Patho-Anatomical Experiments)? *Schweiz. med. Wchnschr.* **73:** 77-79, 1943.

By injecting dihydrotachysterol ("A. T. 10") into rats the author succeeded in producing generalized changes of the skeleton, consisting in general osteoporosis with fibrosis of the marrow. The changes were found in all of the three layers of the labyrinthine capsule. The lesions resembled certain stages of human osteitis fibrosa. Similar results were obtained by Seiferth and Kolb (1938, 1939) in rabbits. These authors assume that the experimental changes are analogous to those in human otosclerosis. They believe that the experiments prove that otosclerosis has a uniform causation and is due to changes in the parathyroid gland; therefore, they introduced the aforementioned preparation of dihydrotachysterol as treatment directed at the cause of otosclerosis.

According to de Gunten, however, there are essential differences between the experimental lesions and human otosclerosis. The reparative phase (formation of new immature bone and other processes) is entirely missing, and ankylosis of the stapes does not occur. The lesions affect the labyrinthine capsule uniformly and are not more marked at the places of predilection for otosclerosis. The author points out that osteoporosis with fibrosis of the marrow is a nonspecific reaction of the skeletal system elicited by various and different metabolic disturbances.

The changes produced by dihydrotachysterol have nothing to do with otosclerosis. The fact that marked changes in the labyrinthine capsule could be produced by a metabolic disturbance favors the assumption that a still unknown metabolic disturbance could be the cause of otosclerosis. It does not, however, justify the use of dihydrotachysterol as etiologic treatment of otosclerosis.

Bustamante Gurria, A. Otosclerosis: Surgical Therapy, *Prensa méd. mex.* **10:** 74-75 (Aug. 15) 1945.

The article consists of a general discussion and a review of the problem.

Corrêa Netto, O., and Mourão, B. M. Otosclerosis and Nicholas-Favre Disease: Contribution to Study of Etiology, *Rev. brasil. de oto-rino-laring.* **13:** 128-138 (March-April) 1945; *Rev. med. e cir. de São Paulo* **5:** 93-101 (March-June) 1945; *Brasil-med.* **59:** 192-196 (May 19-26) 1945.

Among 10 cases of otosclerosis there were 9 in which the Frei reaction was positive, while, at the same time, in 15 cases of other diseases the reaction was negative. Attention is directed to this high incidence. The authors think that the virus of venereal lymphogranuloma could have entered the labyrinth and could have caused the deafness. If this is true, then the Frei reaction could lead to an early diagnosis and an early treatment of otosclerosis.

Díaz-Caneja, E. Blue Sclerotics in Osteogenesis Imperfecta (Lobstein-Vrolik Disease), *Arch. Soc. oftal. hispano-am.* **5:** 630-655 (Aug.) 1945.

This article to date has been unobtainable.

Gomensoro, J. B., and Isola, W. The Syndrome of Blue Sclera, *Rev. oto-neuro-oftal.* **20:** 111-119 (Sept.-Oct.) 1945.

The authors describe the case of a man of 27 years with blue scleras, multiple fractures and bilateral high tone loss of hearing. They think the high tone loss could be due to changes within the mesenchymal tissues of the inner ear. The symptoms and the pathogenesis are described. Disturbances of the endocrine system or anomalies of the mesenchyme are regarded by most authors as the possible etiologic factors.

Holmgren, G. Problem of Otosclerosis, *Nord. med.* **25:** 287-290 (Feb. 16) 1945.

This is a general review of the problem. The classic clinical picture is described. Only the surgical treatment has proved of value, although the improvement of hearing is often only temporary.

In routine histologic examinations it has been shown that 10 per cent of the population harbor otosclerotic foci. In a majority of the cases there is no ankylosis of the stapes. In properly selected cases there is, on opening of the labyrinth, an immediate improvement of hearing as soon as perilymph flows out. One creates a new window in the lateral semicircular canal, and the improvement of hearing lasts as long as this window stays open. The author believes that in otosclerosis there is an increase of intralabyrinthine pressure.

It is too early to decide whether the operation suggested by Wittmaack actually arrests otosclerosis.

Otosclerotic patients show certain symptoms, such as absence of the cerumen of the external canal (50 per cent of the cases), decreased tickle reflex, wide canal, impaired mobility of the handle of the hammer (75 per cent of the cases), abnormal transparency of the drum membrane and abnormal mobility of the pars tensa (50 per cent of the cases). Ankylosis of the stapedial foot plate leads to impairment of the mobility of the ossicles, with dislocation and changes of the joints.

Histologically, blue mantels are found frequently in the bone of the ossicles, and in one case Covell found otosclerotic foci in the malleus and the incus.

Impaired movement of the handle of the hammer interferes with the proper nutrition of the drum membrane, with subsequent atrophy of the latter and of the skin of the meatus.

The author believes that increased intralabyrinthine pressure, even without ankylosis of the foot plate, will cause outward bulging of the round window membrane and will produce conduction deafness because it actually leads to fixation of the foot plate and of the chain of ossicles. The studies of the changes occurring in the ossicles, the drum and the meatus in otosclerosis open up an entirely new field of research.

Mourão, B. M. Possible Etiologic Relations Between Otosclerosis and Nicholas-Favre Disease, *An. paulist. de med. e cir.* **50:** 305-307 (Oct.) 1945.

INDEX OF LITERATURE OF 1946, WITH ABSTRACTS

Altmann, F. Healing of Fistulas of the Human Labyrinth: Histopathologic Studies, *Arch. Otolaryng.* **43:** 409-421 (April) 1946.

The author's summary and conclusions follow:

An incomplete bony closure of a fistula of the lateral semicircular canal was observed three years after operative injury.

The findings in this case were analyzed and compared with those in 19 cases collected from the literature.

In the cases in which a spontaneous fistula had stayed open, the bone had been destroyed very gradually and with a minimum degree of irritation by a slowly growing cholesteatoma. The outer surface of the fistula was covered with stratified squamous epithelium, and the endosteum was normal or thickened but not destroyed.

Infection and hemorrhages in the area of the fistula, destruction of the endosteum and presence of bone chips left behind are the most important factors that promote bony closure of the fistula. Epithelium on the outer surface of the fistula, particularly stratified squamous epithelium, exerts a retarding influence on bone formation.

In contrast to the findings in spontaneous fistulas, rapid bony closure of the vast majority of the fistulas created in fenestration operations took place when the fibrous endosteal membrane had been left intact. This is explained by the

fact that in operative fistulas there is an acumulation of blood and inflammatory exudate in the narrow space between the endosteum and the skin flap with subsequent formation of osteopoietic tissue. In spontaneous fistulas these changes are absent, and the process comes to a standstill when the endosteum has been reached.

The experience gained in fenestration operations, particularly the observation that the fistula in the ampulla of the lateral canal or in the surgical dome of the vestibule shows less tendency to bony closure than one over the canal proper, is confirmed by the anatomic findings in some cases of nontraumatic fistula. The correlations and the differences are explained not only by the effects of the larger size of the perilymphatic space in the vestibule but also by the local differences in the osteogenic activity of the newly formed connective tissue in various parts of the labyrinth.

Anson, B. J. Saccular Diverticula in the Membranous Labyrinth of Mammalian Embryos, *Quart. Bull., Northwestern Univ. M. School* **20:** 421-423, 1946.

Certain aberrant evaginations of the saccule of the fetal ear are described, as part of the course in studies of the otic labyrinth.

Anson, B. J., and Bast, T. H. The Development of the Auditory Ossicles and Associated Structures in Man, *Ann. Otol., Rhin. & Laryng.* **55:** 467-494 (Sept.) 1946.

Anson, B. J. Development of the Auditory Ossicles, *Laryngoscope* **56:** 561-569 (Oct.) 1946.

A study of more than 250 series of sections has been completed to establish the major steps by which the auditory ossicles develop into adult form.

The results of the study may be summarized as follows:

The ossicles follow a remarkable series of developmental steps in attaining adult form—a circumstance which might be expected when it is considered that they are made over to serve, in higher vertebrates, a function very different from their primitive office.

The malleus and the incus are developmentally less aberrant than the stapes. Yet they differ from bones generally not only in possessing a peculiar form but also in lacking epiphysial centers of growth, in having a single ossification center each and in attaining adult size and shape in the fetal body.

The stapes, in addition to displaying the features just named, is unique in the following respects: each crus (corresponding to the shaft of a long bone) becomes channeled to resemble a long bone halved lengthwise, with concurrent sacrifice of its marrow and invasion by mucous membrane and submucosal tissue; the head is likewise excavated and the base reduced to a thin plate of either oval or reniform outline.

Since the ossicles attain maturity while the remainder of the skeleton is still fetal, the opportunity for structural alteration is great. Since they are remodeled elements—having been profoundly altered to make up an ossicular chain—variation is to be expected, and does regularly occur.

These observations must be taken into account in any appraisal of pathologic change occurring in the ossicles. Without knowledge of the kind briefly reported here, normal departure from the so-called typical form could be erroneously interpreted as the result of disease.

Barnett, H. N. Otosclerosis, *M. World* **63:** 812-814 (Feb. 8) 1946.

The author reviews briefly the various aspects of the disease for the general practitioner.

Bast, T. H. Development of the Aquaeductus Cochleae and Its Contained Periotic Duct and Cochlear Vein in Human Embryos, *Ann. Otol., Rhin. & Laryng.* **55:** 278-297 (June) 1946.

The development of the aquaeductus cochleae and the periotic duct is traced through the developmental stages. The difference between the periotic duct and the aquaeductus cochleae is explained. The periotic duct, a channel filled with a loose arachnoid-like tissue, is already clearly indicated in a 9 week (40 mm.) embryo. Already at this early stage its one end communicates with the scala tympani and its other with the arachnoid. In fetuses and infants it does not have a continuous epithelium-lined lumen but is filled with a loose arachnoidal connective tissue.

When the otic capsule ossifies the periotic duct becomes surrounded by the periosteum of the surrounding bone. This bony channel, with its periosteum and the contained periotic duct, is known as the aquaeductus cochleae. The vein of the aquaeductus cochleae for the most part occupies a bony channel of its own and is not in the aquaeductus cochleae.

The periotic duct is a slowly tapering channel. It is widest at its cranial end and narrows in its course toward the scala tympani but widens before it enters the latter.

Campbell, A.; de Villiers, A. J., and Kerr, W. A. Fenestration for Otosclerosis, *South African M. J.* **20:** 252-254 (May 11) 1946.

Campbell opposes the transtympanic approach because he thinks that with the "square-on" approach "it would be extremely difficult in the living patient to make a window without damaging the underlying structures even with a minute trephine or adapted dental burr. Lempert's approach seems to be much safer."

De Villiers questions whether the blood supply of the reflected tympanic membrane will be sufficient to maintain nutrition of the

membrane and save it from complete destruction. He stresses the danger of suppurative labyrinthitis and meningitis should acute otitis media occur when transtympanic fenestration has been performed. This danger is avoided with Lempert's technic, in which the attic is completely separated and shut off from the tympanic cavity.

Kerr objects to an enthusiastic report about Dr. Popper's approach which has appeared in a South African newspaper.

Day, K. M. Appraisal of Fenestration Operation: Report of One Hundred Cases, *Arch. Otolaryng.* **44:** 547-559 (Nov.) 1946.

The author uses the following modifications of the standard technic:

1. He does not remove a wedge of tissue between the tragus and the helix but simply employs a single line incision in this area. It begins at the outer superior margin of the external meatus and is carried upward anterior to the border of the helix far enough to provide an adequate operating field. This incision is made down to but not into the temporal muscle. At the end of the operation it is closed with sutures or clips. This eliminates most of the postoperative pain and discomfort, which means less inflammatory reaction.

2. Partial mastoidectomy only is performed, with just sufficient cellular bone being removed from around the mastoid antrum to provide adequate working space.

3. The use of melted paraffin to fill the cavity at the end of the operation is discarded. Instead paraffin gauze is used, whereby several small pledgets are packed snugly but not tightly over the flap to hold it in position. No attempt is made to stretch the flap or to put tension on it in order to get the thinnest portion over the fenestra. The packing is entirely removed on the fifth day.

There were no serious postoperative complications, such as facial weakness, operative infections or dead labyrinth. Among the 90 patients operated on with Lempert's nov-ovalis technic 76 regained practical hearing, 4 had an unsatisfactory result, 6 showed no improvement, and in 4 the loss of hearing became worse. The fistula closed in 8 of these patients. There were 6 revisions, 3 of which were successful and resulted in practical hearing.

There have been seven pregnancies in this series since operation with no appreciable loss of hearing in either the ear operated on or in the one not operated on.

Fine, J. What Is New in Otosclerosis? *South African M. J.* **20:** 748-749 (Dec. 14) 1946.

This is a general review of the problem, with a discussion of the diagnosis of otosclerosis and of the fenestration operation.

Fowler, E. P. A Report of Progress: Twenty Years' Research in Otosclerosis, Progressive Deafness and Correlated Problems, 1926-1946, Central Bureau of Research, American Otological Society, Inc., 1946.

A report of the research aided by the Central Bureau is given in an illustrated booklet expressing the modern conception of the problems of otosclerosis.

Fowler, E. P. The Value of Individual Hearing Aids for Hard of Hearing Children in Public Schools: Report to the Sub-Committee of the Committee on Problems of Deafness of the National Research Council; the Otological Examination and Follow-Up, *Laryngoscope* **56:** 26-32 (Jan.) 1946.

The primary purpose of the otologic examination of these children was to match them in pairs according to similarities in degree and type of hearing loss; also, these pairs were to be matched as nearly as possible from the point of view of psychology. Over 250 children were examined by the author, and 100 of these were chosen for pairing. Fifty-two children were paired (26 pairs). The one child was provided with a hearing aid, and the other was not. The 48 remaining children were not closely pairable, but half of them were supplied with hearing aids. One extra child was used as a "spare."

All of these children had been tested at least once previously with both 4-A and 2-A audiometers in the public schools. The tests were made in an efficiently soundproofed room in the author's office; the examinations and tests were repeated at least once a year over a period of three years (12 children had only two tests).

Fowler's method of weighting as adopted by the Consultants on Audiometers and Hearing Aids of the American Medical Association was used, but no allowance was made for the recruitment phenomenon or the variable ratio between the two ears. Otherwise, the percentages of loss of capacity were obtained by using Fowler's method. The author made exhaustive otologic examinations, the results of which are listed. The most spectacular gains in hearing were obtained in the cases of pure obstructive deafness in which there was no more than a 30 per cent loss at the first testing.

A scatter chart shows the distribution of the losses and the subsequent gains and losses. Diagnostically, the cases fell into four main groups:

Pure nerve deafness	8
Nerve deafness with some obstructive deafness	57
Obstructive deafness with some nerve deafness	5
Pure obstructive deafness	31

The statistician, Dr. Irving Lorge, reports:

It is significant that the variation in hearing among individuals is greater than the variation between the means of the aid and the no-aid groups respectively, but the variation among individuals is so great that it obscures any genuine differences between groups.

The variation in the gains of individuals is so variable that any distinction between aid and no aid cannot be clearly revealed with the number of cases utilized in this experiment.

The data which stand out most sharply are: (1) the number of children who improved to some extent (namely, 78 per cent), compared with the number who lost to some extent (namely, 22 per cent); (2) the number who improved over 20 per cent (namely, 22 per cent) (3) the number who at the last test showed less than a 30 per cent loss (namely, 39 per cent), and (4) the number who were deafened (to some extent at least) from auditory neural lesions (70 per cent). It is evident that at least one third of the children showed a marked improvement in hearing. (About 40 per cent improved to the 30 per cent loss level.)

The distance at which the soft voice was heard varied directly with the per cent gain or loss of capacity to hear the speech frequencies.

"Had some special 'cure' for deafness been employed, these statistics might be used to show that the 'cure' was responsible for the remarkable 'restorations' of hearing. Obviously any such claim would be unwarranted."

Fox, G. M. Fenestration for Otosclerosis, *South African M. J.* 20: 479-481 (Aug. 24) 1946.

The author reviews the methods used for the preoperative examination of the patients and the operative technic which he studied during a recent visit to the United States. He reports that fairly successful results were obtained in from 40 to 50 per cent of the cases in which the operation was done.

Greenfield, S. D. An Evaluation of the Lempert Fenestra Nov-Ovalis Operation in the Treatment of Otosclerosis: Report on Thirty-Six Patients Who Were Selected for This Operation, *Arch. Otolaryng.* 43: 25-30 (Jan.) 1946.

The author comes to the following conclusions:

1. The Lempert fenestra nov-ovalis operation is the only form of treatment for the restoration of serviceable, practical hearing in patients with otosclerosis.

2. No man should attempt the operation unless he has spent sufficient time studying and preparing himself for this work under competent instruction.

3. The operation is a safe procedure in the hands of those especially trained to do the operation.

4. The patients most suitable for operation are those suffering with the purely conductive type of deafness without any evidence of nerve involvement.

Hagens, E. W. Pathology of Otosclerosis, *Quart. Bull., Northwestern Univ. M. School* **20:** 192-198, 1946.

The problem is reviewed.

Characteristic of otosclerosis, foci occur in localized patches, and with hematoxylin and eosin stain the pathologic bone stands out . . ., usually staining quite intensely. Some authors have believed that this staining reaction is due to the excess of calcium in the foci so that even after decalcification there would be sufficient calcium to produce a deeper stain with hematoxylin. Another view has been that a peculiar chemical characteristic of the ground or cement substance in the focus produces the peculiar reaction. Experiments by the writer have shown that it is the unusual affinity of the focus for the alum of the mordanted hematoxylin that results in the deeper staining reaction. No proof for the theory of excess calcium in the foci was found in tests using alizarin and purpurin.

The so-called nerve degeneration frequently found clinically in cases of otosclerosis does not manifest itself in morphologic changes in the inner ear or the cochlear nerve. The author was unable to confirm the findings of Gray regarding the loss of neurokeratin in the cochlear fibers.

Hall, I. S. The Surgical Treatment of Deafness, *Irish J. M. Sc.*, March 1946, pp. 80-84.

This is a general review of the question. The author describes Lempert's fenestra nov-ovalis technic without stopple. He emphasizes, however, that there is no essential difference between the endaural and the postauricular approach. He prefers the latter. For making the fistula he uses a dissecting microscope with a magnification of 6 to 8 diameters.

Hall, I. S. The Fenestration Operation for Otosclerosis, *Brit. M. J.* **2:** 647-649 (Nov. 2) 1946.

The purpose and the indications for the fenestration operation are discussed. Lempert's fenestra nov-ovalis technic is described, and reference is made to the equipment necessary for its performance. Out of 118 patients operated on eight months or more ago 82, or 69 per cent, still show an improvement, the degree of which is not stated. There were two fatalities. One patient, an elderly woman, died of acute cardiac collapse shortly after the operation was completed. Another, a man of 43, died of acute morphine poisoning some hours after the operation. He had received the usual dose of postoperative sedative. Pregnancy has occurred in several patients, and its effect has been variable: In some cases there has been a definite loss of hearing; in others, no change.

Kobrak, F. Contributions to Functional Pathology: IV. Clinical Notes on Progressive Congenital Deafness. *J. Laryng. & Otol.* **61:** 49-91 (Feb.) 1946.

The author's conclusions follow [2]:

1. Otosclerosis is considered from the viewpoint of a primordial form of progressive congenital deafness. There appear to be three genetically distinguishable forms of progressive congenital deafness, the descendants of the primary *"primordial otosclerosis"*: [*a*] osseous otosclerosis, [*b*] progressive cochlear deafness, and [*c*] a compound of otosclerosis with progressive cochlear deafness. The well known perivascular . . . osseous changes [in otosclerosis] are regarded as the cause of ischemic lesions in the organ of Corti. This occurs . . . in the individual cases; [however] it becomes . . . of genetic importance with mutation. The . . . eventualities of [the] genetic splitting up provide a genetic explanation of the commonly accepted view that otosclerosis and progressive cochlear deafness are varieties of the same condition.

2. The diagnostic significance of vestibular signs in progressive congenital deafness depends on the detection of changes in the "mute area" of the petrous bone, and, so, of conditions suggestive of latent congenital deafness. Vestibular tests are therefore regarded as an indispensable part of functional tests for progressive congenital deafness, especially for early diagnosis.

3. Detailed vestibular and some new auditory tests indicate certain changes in progressive congenital deafness which are common to both otosclerosis and progressive cochlear deafness and make the . . . clinical picture of progressive congenital deafness more intricate than it appeared to be when [it was] based solely on the old routine auditory tests. Thus a certain confusion and diagnostic deadlock arose, in the field of clinical otology, analogous to a certain pathological-anatomical confusion due to advancing histological research on changes in progressive congenital deafness which, like the clinical findings, are also common to both otosclerosis and progressive cochlear deafness. However, the histological observations when compared with our new clinical findings . . . seem to corroborate each other: a clue to the clarification of the cloudy diagnostic situation is suggested [by certain] laws of genetics [*vide* conclusion 1].

4. According to our clinical observations, the old classical form of predominantly ankylostapedial otosclesosis is less frequent than other forms of otosclerosis in which ankylostapedial signs are not predominant or not even detectable. The manifest form or some concealed forms of "basal cochlear otosclerosis" are of importance. These clinical conclusions are much in accordance with pathological-anatomical findings of other authors.

5. The therapeutic approach to prophylaxis is the same for the diverse forms of progressive congenital deafness, less because of their genetical identity than because therapy and prophylaxis can so far be directed only against an abnormality which is obviously common to both clinical otosclerosis and progressive cochlear deafness: [it does this] by combating abnormal activity in the tympanic muscles.

6. Progressive congenital deafness shows several types of behaviour of prognostic importance. These may be graded in an "order of congenital types" of deafness. The locus of the individual type of congenital deafness in this order

2. In quoting the article the reviewer has made certain slight changes aimed at clarifying the presentation.

seems to reveal some clinical signs with prognostic implications as to the severity of the lesion.

Lindsay, J. R. Histologic Observations on Healing of Labyrinthine Fistulas (Produced by Fenestration Operation) in Monkeys, *Arch. Otolaryng.* **43:** 37-48 (Jan.) 1946.

The author reports the results of experiments carried out on a series of 48 monkey ears. He offers two conclusions regarding the regeneration of bone:

1. The fistula in the bony semicircular canal always closes by formation of new bone unless certain measures are carried out.

2. The regeneration of bone occurs rapidly from the periosteal layer and more slowly from the endosteal surface of the capsule. Complete closure may occur from either or both layers.

Attempts to prevent regeneration of periosteal bone resulted as follows:

1. The use of a cutaneous flap reflected from the posterior wall of the external auditory meatus without removal of the annulus tympanicus was not successful. The situation of the fistula in a concavity tends to prevent close contact with the covering flap throughout the healing period.
2. Thiersch grafts of hair-bearing skin were frequently successful in preventing closure for several months but proved to be unsatisfactory because of occasional degeneration and because of the presence of hair fragments beneath the graft, which stimulated formation of callus and eventual closure.
3. Conjunctival grafts were used with a sufficient degree of success to warrant further laboratory investigation.
4. The use of a tympanomeatal flap according to the Lempert technic has given the best results as indicated by the response to the test for fistula.

Commenting on the application of any covering graft or flap, the author states:

A factor predisposing to success . . . is the locating of the fistula on a convex surface rather than in a localized concavity. Such a site is obtainable slightly distal to the ampulla when the posterior bony wall of the external auditory meatus and the rim of the annulus tympanicus are adequately removed. The evidence suggests that any fistula remains open only by virtue of the union which occurs between the membranous labyrinth and the covering flap to the exclusion of osteogenic tissue. The perilymphatic space always becomes separated from the covering flap either by a layer of new bone or by the membranous labyrinth. Measures necessary to permit fibrous union between the membranous labyrinth and the covering flap have been shown to be:

1. Bone fragments and endosteum must be completely removed from the fistula.

2. The normal contour and position of the membranous canal must be preserved so that it makes uninterrupted contact with the covering flap.

Failure in this was commonly caused by allowing bone fragments to slip between the bone and the endosteum or between the endosteum and the membranous canal

and by injuring or rupturing the membranous canal so that it became depressed or displaced.

Maybaum, J. L. Status of the Fenestration Operation for Otosclerosis: Presentation of Permanently Improved cases, *J. Mt. Sinai Hosp.* **13:** 1-5 (May-June) 1946.

The author reviews the problem. An improvement of hearing which has been maintained for one year after a fenestration operation may be regarded as permanent. This statement is based on the collective experience of a few thousand cases in which this operation was performed. Three cases are discussed in which hearing was thus permanently improved, the gain having been maintained for twenty-six months in 2 and for thirty-two months in 1. By means of the fenestration operation (the fenestra nov-ovalis technic of Lempert) and proper selection of cases of otosclerosis, a "successful outcome" may be expected in 70 to 85 per cent of the cases. Failures result from poor selection of cases, faulty technic, overactive osteogenesis and postoperative labyrinthitis.

Pienaar, P. de V. Fenestration and Early Hearing Improvement: Case Record, *South African M. J.* **20:** 405-409 (July 27) 1946.

The author reports the results of audiometric examinations of a 30 year old woman made before and fourteen days after a fenestration operation for otosclerosis. The operation was performed by Dr. O. Popper. The transtympanic approach was used, and a cartilaginous stopple was placed in the window. At frequencies below 2048 cycles per second an increase of hearing acuity was found, varying from 45 decibels at 128 cycles to 10 decibels at 2048 cycles. At 4096 cycles the threshold dropped 15 decibels below the preoperative response. The author was surprised to find a more or less level gain for all frequencies in the ear not operated on.

Popper, O. Fenestration of the Labyrinth: I. The Transtympanic Route, *J. Laryng. & Otol.* **61:** 24-37 (Jan.) 1946.

Before the fenestration operation can hope to enjoy popularity and to be performed with the essential degree of competence by a large number of otologists, a complete reorientation of ideas concerning the surgical approach to be made to the vestibule must take place.

To approach tympanic structures through the mastoid process seems a surgical absurdity, and "until otologists come to grips with this anachronism, so long will this operation remain in the hands of the very few."

The transtympanic approach offers many advantages, such as "square-on" presentation of the operative field, easy access, perfect

hemostasis, superlative landmarks, perfect visual control, shorter duration of the operation and less operative trauma and postoperative reaction. The author's description of his technic follows, with some necessary condensations in the brackets:

[Up to the point of fenestration local anesthesia, with heavy premedication, is used; when the actual fenestration begins, pentothal sodium is given intravenously.]

The skin incision is over the tragus . . . or in the fold between the tragus and the temporo-mandibular articulation; [it is about 1½ in. (3 to 4 cm.) long]. The skin is reflected off the cartilage of the tragus, and blunt dissection is carried over the anterior surface of the cartilage of the meatus and the latter's attachment to the tympanic plate. Further blunt dissection clears the bone of the anterior surface of the tympanic plate until the latter is exposed for ½ inch. . . . No vessels, nerves or other structures of consequence are encountered. . . . The tissues are retracted forward *en masse,* pushing the temporo-mandibular articulation with them.

[A second incision is made through the attachment of the cartilage down to the tympanic plate] and through the underlying skin, thus opening into and revealing the divided lumen of the meatus itself. . . . A rongeur of suitable size is now inserted into the bony meatus, to grasp and remove a large part of the tympanic plate and its investment of skin. . . .

[Now] with side cutting dental burrs the upper, lower and deep edges of the partly removed tympanic plate are trimmed until the entire wall down to the tympanic ring at the insertion of the drum is cleared. The drum now stands clearly revealed and, be it noted, "square-on" and not obliquely sloping away as when viewed through the meatus. . . .

The next step is the detachment of the drum with adjacent meatal skin—or the fashioning of the tympanomeatal flap. . . . [The latter should cover the area above the fenestration, but should not be too large.] After infiltration an incision is made in the skin of the meatus down to the bone, somewhat less than half an inch . . . from the drum [membrane, and] around the remaining part of the meatus. This partial cuff of skin is reflected from the bony wall down to the tympanic ring, from which it is carefully detached with gentle strokes of a fine curette so that the skin, plus the drum [membrane], can be reflected forwards as one continuous whole over the handle of the malleus. The contents of the middle ear now stand revealed. . . . The ampulla dome region [of the labyrinth] is still overhung by the lateral wall of the attic. . . . [The latter is now removed with dental burr, and in this way the incus is exposed.] The incus is now removed; [the head of the malleus is not amputated because it does not obstruct the view. Now the surgical dome of the vestibule is opened with a diamond paste burr of 2 mm. diameter which produces a circular hole in the bone. Suction irrigation is used. A piece of cartilage is taken from the tragus and inserted into the fistula. Then the tympanomeatal flap is turned over the fistula and tucked well in with paraffin ribbon gauze impregnated with sulfanilamide and penicillin. The first dressing is done on the seventh day.

The tympanomeatal flap and the exposure of the attic by the transtympanic route offer an alternative to the radical operation for chronic otorrhea due to atticoantral disease.

Instead of the surgical dome of the vestibule the "cochlear vestibule" may be fenestrated. The cochlear vestibule is the part of the vestibule which lies above the basilar membrane and above the lamina spiralis ossea.]

The transtympanic technique is carried through up to the completion of the tympanomeatal flap. The attic wall is left intact. The malleus is gently displaced forward until a space in front of the anterior crus of the stapes is cleared on top of the "shoulder of the promontory," which is parallel to and below a line continuous with the tendon of the stapedius. The fenestration should lie on, but not cross, the horizontal tangent of the upper curvature of the round window. . . . [The fenestration is done with a diamond paste cylinder 1.5 mm. in diameter. The window may be closed with a piece of cartilage.] The "cochlear vestibule" is remote from the nerve supply to the ampulla, saccule and utricle. These nerves ramify in the dome of the vestibule to supply the respective parts of the labyrinth. Post-operative labyrinthine disturbances may, therefore, be expected to be less severe and more evanescent than when fenestration takes place immediately adjacent to these nerves at the ampulla and dome, as there is less liability to trauma. . . .

[Fenestration of the vestibule, the author states, will succeed in restoring hearing only if the round window membrane is functionally unimpaired. He believes that cases of otosclerosis with a "low cochlear nerve function reserve" are caused by impaired function of the round window membrane, which leads to decreased mobility of the perilymph. This prevents the vibration from reaching the upper region of the cochlea. Thus the latter receives "no stimulus, and does not respond to sounds in the upper register, despite the fact that the nerve endings in the spiral organ are functionally unimpaired. Closure of the round window could produce such a situation."

"Fenestration of the scala tympani, alone or in addition to vestibular fenestration, may prove effectual in such cases of profound mixed deafness. These procedures" are, however, still "in an experimental stage."

The author believes that closure of the round window would produce the same symptoms as fixation of the stapes and that a test for round window closure is imperative. "The site for fenestration of the scala tympani must lie below the attachment of the basilar membrane. . . If a tangent be drawn 30° to the horizontal touching the upper curvature of the fossula of the round window, the site of fenestration lies below and behind this line, and between it and the lower curvature of the round window. The attachment of the basilar membrane within the promontory wall lies above and in front of this area."]

Cawthorne's operation for Ménière's disease and Wright's method of injecting alcohol into the oval window would be facilitated by the transtympanic approach.

Because of Lempert's reports that successful fenestration abolishes tinnitus in otosclerosis, the author believes that intolerable tinnitus should be considered an indication for fenestration of the labyrinth.

Popper, O. Fenestration: Transtympanic Approach, *South African M. J.* **20:** 134-137 (March 23) 1946.

This is an abbreviated version of the article in the *Journal of Laryngology and Otology* just reviewed.

Popper, O. Fenestration for Otosclerosis, Correspondence, *South African M. J.* **20:** 286 (May 25) 1946.

The author defends his transtympanic approach against Drs. Campbell, de Villiers and Kerr. He emphasizes that he made no claims

whatsoever for fenestration. He only described a new approach by which the fenestration can be done without destroying the mastoid process.

Portmann, G. The Treatment of Progressive Loss of Hearing by the Fenestration Operation of Lempert, *Presse méd.* **54:** 301-302 (May 11) 1946.

The author describes Sourdille's technic and Lempert's fenestra nov-ovalis technic in which a platinum-iridium frame is inserted into the window.

Schenck, H. P. Thyroxin Therapy in Otosclerosis, *Arch. Otolaryng.* **44:** 43-50 (July) 1946.

Thyroxin introduced into the middle ear cavities in 64 persons with clinical manifestations of otosclerosis failed to affect the hearing to an extent beyond the normal variations experienced in otosclerosis.

Shambaugh, G. E., Jr. The Fenestration Operation for Otosclerosis, *J. A. M. A.* **130:** 999-1006 (April 13) 1946.

The author undertook experimental and clinical investigations in order to determine as far as possible the permanence of the artificial fistula created in the labyrinth by the fenestration operation as it is now done.

Fenestrations were performed on monkeys, according to the fenestra nov-ovalis technic, with use of the irrigating apparatus and the microscope.

By killing the animals at different intervals and examining the ears microscopically one is able to construct what occurs in the human ear after the fenestration operation.

Osteogenesis which tends to close the fistula is governed by the following factors:

1. The sluggish response made by the enchondral layer of the labyrinthine capsule to trauma.
2. The inhibition of osteogenesis exercised by stratified squamous epithelium.
3. The stimulation of osteogenesis caused by presence of bone dust and fragments.
4. The osteogenetic reaction of traumatized endosteum.
5. The inhibiting effect of a smooth polished bone surface.
6. The tendency of the intact membranous labyrinth that has become closely adherent to the skin flap to hold the mouth of the fistula open.

By attention to all of these factors it has been possible for the first time to make a labyrinthine fistula in an experimental animal which would remain open for more than a year. With this technic the closures in the human ears have been reduced to less than 5 per cent after two years.

Clinical analysis of the results obtained in 930 consecutive fenestrations over seven and one-half years indicates that osteogenesis tending to close the fistula is, as a rule, no longer active two years after operation; 82 per cent of the fistulas closed within one year after operation and only 1 of 53 after a period longer than two years. The two year hearing result of the fenestration operation may be regarded as the permanent result.

Perfectly normal hearing is almost never attained with the operation, though in many cases the hearing is sufficiently close to normal to be regarded as normal by the patient and his friends. The average gain of the 88 per cent of the patients who maintained their maximum improvement of hearing two years after operation (fenestra nov-ovalis technic with irrigation and use of a dissecting microscope) was 28.9 decibels. In some cases the improvement is not sufficient to be of practical value. In 5 per cent of the cases the hearing is not improved, is made worse or is entirely destroyed in the ear operated on. For this reason the poorer hearing ear should be chosen for operation.

Shambaugh, G. E., Jr., and Juers, A. L. Surgical Treatment of Otosclerosis: A Preliminary Report on an Improved Fenestration Technic, *Arch. Otolaryng.* **43**: 549-567 (June) 1946.

The authors describe a new fenestration technic developed at Wesley Memorial Hospital and Northwestern University Medical School. They emphasize that an improvement of hearing of the fenestrated ear which has been maintained for two years after operation may be regarded as permanent.

The new technic embodies several major and a number of minor changes of technics developed elsewhere.

The major changes fall into three categories: features to decrease the frequency of bony closure, features to enhance the average decibel gain and features to lessen postoperative labyrinthitis.

The measures to prevent bony closure are:

1. The periosteal bone is removed in a large area around the fistula, since observations on the monkey showed that enchondral bone responds to trauma with new bone formation less rapidly than does periosteal bone.

2. Bone dust is instantaneously removed from the fistula with suction irrigation because bone particles and bone dust stimulate osteogenesis.

3. Trauma of the endosteum within the labyrinth is avoided because bone proliferating from the endosteal layer responds to trauma with active osteogenesis.

4. Bone particles are removed from the tympanomeatal skin flap. While periosteum itself probably inhibits osteogenesis, any bone particles that remain adherent to it will act to stimulate osteogenesis.

5. Full advantage is taken of the osteogenesis-inhibiting effect of squamous epithelium, first, by thinning the thickened outer portion of the skin flap, and second, by making the fistula at the top of a rounded mound rather than on the surface of a plain or at the bottom of a depression, so that the skin clings ever more closely to the margins of the fistula as healing and contraction proceed. The very thin skin from the anterior meatal wall is swung around to cover as much of the fistula as possible.

After a successful fenestration the patient hears largely by means of sound vibrations carried by the tympanic membrane to the labyrinthine fistula. The following measures to enhance the mobility between the tympanic membrane and the fistula have been incorporated in the new technic: The fistula is placed laterally, nearer to the facial nerve; the tympanomeatal skin flap is placed under tension, and the mucosa covering the bony horizontal semicircular canal is preserved.

In order to lessen postoperative serous labyrinthitis an attempt is made to minimize the inflammatory reaction of the skin flap, which is done by using sea sponge packing, and to prevent the blood cells and serum from gravitating to the cochlea. For this purpose the patient is prevented from lying on the untreated ear, because then the cochlea of the treated ear would be dependent to the fistula. This is achieved by the use of a head frame which keeps the patient lying on his back or on the treated ear.

Shambaugh, G. E., Jr. Preliminary Results with a New Fenestration Technique, *Illinois M. J.* 90: 264-268 (Nov.) 1946.

This article is similar in substance to that by Shambaugh and Juers (*Arch. Otolaryng.* 43: 549-567 [June] 1946), just reviewed.

When the factors that were found experimentally to influence the osteogenesis which tends to close the fistula were applied to the operation as performed on the human subject, the incidence of failure due to bony closure was reduced to 5 per cent in cases tested after two years.

Postoperative serous labyrinthitis has been the most frequent cause of failure since the measures to prevent bony closure were adopted. Blood and serum that escape into the labyrinth from the skin flap appear to be the chief cause of this labyrinthitis. The sea sponge and head frame technic of preventing labyrinthitis has resulted in a striking

improvement of the early hearing results and may be expected to improve the permanent hearing results.

The new fenestration technic developed at Wesley Hospital and Northwestern University embodies a number of changes from other technics; the most important ones are: enchondralization of the fistula; constant irrigation of the field and use of the microscope while making the fistula; scrupulous avoidance of traumatization of the endosteum of the labyrinth; use of sea sponge packing and a head frame to prevent postoperative serous labyrinthitis.

Shambaugh, G. E., Jr. Results of the Fenestration Operation for the Surgical Treatment of Deafness, *Kansas City M. J.* **22:** 18-21 (March-April) 1946.

This is a general review of the problem. At the present time the percentage of failures due to bony closure is 5 per cent. In 86 per cent of the cases a significant improvement of hearing is permanently maintained.

Shambaugh, G. E., Jr. Factors Influencing Osteogenesis Following the Fenestration Operation: Observations on the Monkey, *Arch. Otolaryng.* **44:** 644 (Nov.) 1946.

These factors were presented in an article published in *The Journal of the American Medical Association* (**130:** 999 [April 13] 1946), reviewed in the foregoing pages.

Walsh, T. E., and Silverman, S. R. Diagnosis and Evaluation of Fenestration, *Laryngoscope* **56:** 536-555 (Sept.) 1946.

The examination of the patient takes approximately six hours and is performed on two successive mornings. On the first morning a pure tone audiogram of both air and bone conduction is made, followed by certain speech tests of both ears in the free field. On the second morning the pure tone audiometric examination is repeated and other speech tests are given. "If the patient wears a hearing aid he is tested in the free field with the volume control of the aid set at maximum usable gain setting."

The speech tests were those developed in the Psycho-Acoustic Laboratory, Harvard University. The authors used test 9, consisting of "six spondaic words given to the patient through an earphone, beginning at an appropriate intensity so that he hears all six words, and then the groups are attenuated in four db steps. Threshold is the level at which he hears 3, or 50 per cent, of the words." In addition test 12 was used, consisting of four sentences at each level, given as in test 9.

Finally the P.-B. test [3] was employed. It consists of fifty phonetically balanced words given "at levels progressively attenuated in any desired step interval. Threshold is represented by the point at which the patient hears 50 per cent of the words."

Concerning selection of patients, the authors state that one should not adhere too rigidly to the classic criteria of cases suitable for fenestration.

> . . . Some of our most sucessful results were in patients over fifty years of age. . . . It has been assumed that loss of hearing by bone conduction indicates cochlear damage. This is not necessarily so. Variables in the thickness of the cortex, the pneumatization and the thickness of the trabeculae in the mastoid together with the variation in thickness of the subcutaneous tissues must influence the conduction of sound to the cochlea from a source placed on the bone behind the ear. . . . It is evident that a prognosis based on the bone conduction curve would be erroneous. . . . However . . . ***not all*** patients with a high tone loss by bone conduction should be considered suitable for fenestration.

The authors pay little attention to the bone conduction test "except from the point of view of general screening of patients."

An important clinical criterion is the fact that the otosclerotic person speaks in a "still, small voice" and articulates normally. The patient with a nerve loss has a poorly modulated loud voice and frequently slurs the consonants *s* and *th*. The authors describe a method of selecting cases suitable for operation. Without specifically mentioning the work carried out by Fowler Sr., they base their test on the fact that otosclerosis does not show recruitment of loudness, whereas nerve deafness shows recruitment.

With a special apparatus, they "deliver to the patient speech at high intensity levels relatively free from distortion. If the patient's articulation score increases proportionately with intensity . . . then that patient has adequate cochlear function and is suitable for the operation." If "increasing the intensity does not proportionately elevate the articulation score after a certain maximum has been reached, . . . adequate cochlear function is not present," and fenestration is contraindicated. "The suggested diagnostic procedure does not detect nerve deafness above 3500 cps., but this area is of little practical significance for the purposes of the test."

Pure tone audiometry as the sole criterion for evaluation of the results of the fenestration operation "is open to serious objection." The authors agree with the now accepted opinion that "thresholds for pure tones are not always adequate for gauging auditory function above threshold." Furthermore:

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3. The tests (nos. 9 and 12 and P.B.) are described in: Articulation Testing Methods: II. O.S.R.D. Report no. 3802, Nov. 1, 1944.

. . . postoperative pure tone audiometry neglects the change in the size and shape of the external transmission pathway which results from varying degrees of exenteration of bone cells. . . . This fact may account for the discrepancy between postoperative pure tone audiometric results and observed social responses of many fenestrated patients.

The basic aim of fenestration surgery is "restoration of the patient to social adequacy in a dynamic acoustic environment." The question whether the patient has achieved social adequacy or not is determined by his postoperative "articulation score or index." The articulation score at 20, 35 and 50 decibels (i. e., the percentage of test words understood at these frequencies) is determined and then divided by 3. If the resulting figure is 50 or more, the patient has been socially rehabilitated. If the figure is less than 50, he has not been rehabilitated, no matter how great the gain was.

Williams, H. L. Selection of Patients for the Fenestration Operation for Otosclerosis, *S. Clin. North America* **26:** 876-889 (Aug.) 1946.

Williams discusses the probability of a successful result as follows:

If in a given case the bone conduction by fork testing is prolonged ten to fifteen seconds or more beyond the air conduction . . . in the 1024 d.v. frequency, and the audiometric curve does not show evidence of cochlear atrophy and there is no visible evidence of deposit of scar tissue in the tympanic membrane and a presumptive diagnosis of clinical otosclerosis can be made, the probability of such a patient getting an initial restoration of the hearing to a level at which he is under no handicap in hearing normal conversation is about 70 per cent of cases in which operation is performed. This constitutes the so-called selected group. It should be remembered that about 10 to 15 per cent of those securing an initial good result will experience closure of the fenestra sooner or later.

If in a given case a presumptive diagnosis of clinical otosclerosis is made and the patient meets all criteria for the selected group except that evidences of scarring are present in the drum of the ear to be operated on, the probability of securing an initial good result may be estimated at 60 per cent.

If in a case of clinical otosclerosis evidence of cochlear degeneration is found but this does not appear to involve the speech range and the loss of hearing nowhere falls below the 50 decibel line, a 50 per cent probability of a good result may be fairly estimated if no other unfavorable conditions are present. [However] when evidences of nerve degeneration are present . . . the probability of a reactive labyrinthitis resulting in severe loss of hearing as the result of operation is increased.

If in a case of clinical otosclerosis degeneration of the cochlea above the speech range seems apparent and the hearing curve is down to the 60 decibel level or below, . . . a 30 per cent probability of an initial good result may be estimated.

If evidence of nerve degeneration appears to involve any of the frequencies in the speech range, no more than a 15 per cent probability of a good initial result should be offered.

There would seem to be little or no justification for operating if the otosclerosis is unilateral . . .

The author quotes Holmgren as saying that "even an unsuccessful operation tends to stop the progress of the pathologic process in the ear operated on."

Williams, H. L. The Fenestration Operation for the Restoration of Hearing to Conversational Levels in Loss of Hearing Due to Clinical Otosclerosis, *Proc. Staff Meet., Mayo Clin.* **21:** 320-325 (Aug. 21) 1946; *J. Rehabilitation* **12:** 9-13 (Dec.) 1946.

This is a general review of the problem. An attempt is made to promote a better understanding of the purpose and the results of the operation by answering the usual questions that are asked by both physicians and the laity.

Wojniak, F. The External Ear and Drum Membrane in Otosclerosis, *Arch. Otolaryng.* **44:** 249-251 (Aug.) 1946.

A careful comparative study of the external auditory meatus and the tympanic membrane was carried out in 100 patients with otosclerosis and 100 controls.

Atrophy of the skin of the meatus and abnormal or unusual thinness of the drum membrane appear to be more frequent in persons who are deaf than in persons with normal hearing but no more frequent in otosclerosis than in other forms of deafness. Except for Schwartze's sign, which is present twice as often in patients with otosclerosis as in patients with other forms of deafness, and five times as often in patients with otosclerosis as in persons with normal hearing, and the apparent absence of mobility of the handle of the malleus in a greater proportion of persons with otosclerosis than of the controls, there is nothing characteristic in the external ear and the drum membrane to help in differentiating otosclerosis from other forms of deafness. There even appeared to be no relation between the amount of cerumen and deafness.

Wojniak, F. The External Ear and Drum Membrane in Otosclerosis, *Ann. Otol., Rhin. & Laryng.* **55:** 406-422 (June) 1946.

A study of 100 cases of otosclerosis and 100 controls is reported. In 70 cases the disease was unilateral and in 30 it was complicated by other forms of deafness.

In patients with otosclerosis the external auditory canal is generally larger than that of normal hearing subjects but corresponds closely with that of patients suffering from other forms of deafness. The amount of cerumen appears to be the same in cases of otosclerosis, normal hearing or impaired hearing from other causes. The skin of the external canal appears to be atrophic as often as it appears to be normal in patients with defective hearing, regardless of the type of deafness. Only 12.8 per cent of the normal hearing patients show signs of atrophy. The sensitivity of the skin, or the so-called "tickling reflex," shows no appreciable variations. The cough reflex appears to be of no diagnostic significance.

The drum membrane appears to be thinned out abnormally only slightly more frequently in otosclerosis than in other forms of deafness. There is no marked variation in the vascular reflex; one could say, however, that in normal hearing subjects this sign is more readily elicited. Schwartze's sign appears to be highly suggestive of otosclerosis, being present in 21 per cent of the patients with that disease. However, it was present in 10 per cent of those with other forms of deafness and in 4.2 per cent of the normal hearing patients. Mobility of the handle of the malleus appears to be absent in 47 per cent of the patients with otosclerosis, compared with 23.3 per cent of those with other forms of deafness and 14.2 per cent of those with normal hearing. The difference in the mobility of the pars tensa between the three groups studied is negligible.

Worral, J. D. Surgical Treatment of Deafness, *McGregor Clin. Bull.* **7:** 11 (Dec.) 1946.

Case Reports

SOLITARY NEUROFIBROMA OF THE SUBMAXILLARY REGION

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IN 1908 VEROCAY [1] first described the histologic appearance of a highly differentiated tumor which resembled the nerve sheath within which it was commonly found, and in 1910 he gave the term "neurinoma" to this type of tumor. A review of the literature reveals such names applied to this tumor as "neuroma," "neurinoma," "palisading neurinoma," "neurofibroma," "solitary neurofibroma," "perineurial fibroblastoma," "fibroma of nerves," "peripheral glioma," "schwannoma," "gliofibroblastoma" and "lemmoma." This variation in terminology is evidence of the confusion which has existed because of uncertainty as to the origin of tumors of this type.

There are two main trends of thought regarding the origin of these tumors. The branching, anastomosing processes resembling connective tissue, which give rise to fibrils and collagen and are a specific product of the fibroblasts, have suggested to Penfield [2] that these tumors originate from the perineurial fibroblasts and are therefore mesodermal in origin. The early works of Bard, Durante, Francini, Verocay and Antini [3] favor the ectodermal hypothesis. Nageotte and Masson [4] thoroughly studied this type of tumor and reproduced it experimentally, proving conclusively the schwannian or neurectodermal hypothesis.

Thus, such a tumor may occur in connection with any peripheral nerve or nerve root, more frequently the latter. Of the cranial nerves, the eighth is most frequently affected. The spinal nerve roots, more so the posterior roots, and the sympathetic nerves are frequently involved.

The tumor is most frequently round or oval, and may be smooth or nodular. It is usually well encapsulated, but in some cases may be infiltrative. It may be quite firm and solid in consistency or, on the other hand, soft and fluctuant.

Although the gross appearance may show wide variations, the microscopic aspect remains the same. Antoni [1] described two types of tissue seen microscopically. Both types are present in the tumor in varying amounts. Type A presents an orderly appearance of long slender fibers with silver-staining properties, similar to connective tissue. These fibers may be straight or serpentine, passing between the cells. The nuclei of the cells are elongated, with blunt ends, and the elongated branching and anastomosing cells form a syncytium. A most characteristic feature of tissue of this type is a palisading of the nuclei produced by an orderly parallel arrangement of the cell nuclei. Some areas resemble the struc-

1. Cited by Stout.[5]
2. Penfield, W.: The Encapsulated Tumors of the Nervous System: Meningeal Fibroblastoma, Perineurial Fibroblastoma and the Neurofibromata of von Recklinghausen, Surg., Gynec. & Obst. **45**:178-188 (Aug.) 1927.
3. Cited by Masson.[4]
4. Masson, P.: Experimental and Spontaneous Schwannomas (Peripheral Gliomas), Am. J. Path. **8**:367-388 and 389-416 (July) 1932.

ture of the Wagner-Meissner tactile corpuscles. Type A tissue, although occasionally becoming necrotic, with resulting loss of cells, may still retain its fibrillar structure.

Type B tissue is quite different in appearance. No orientation of cells is present. The cells and fibers are haphazardly arranged, and microcystic degeneration may be present. The fibers are of the reticulin type present in type A tissue. Collagen bands are rare. Masson [4] agrees with Antoni that type B tissue represents a degenerative phenomenon, a jellification of type A tissue. Blood pigment and large vacuolated phagocytes, so-called foam cells, are also considered characteristic findings in this type of tumor.

The symptoms of such tumors usually result from the presence of the mass and depend on its location and the nerve trunk involved. Intracranial or spinal tumors present problems to the neurologist and the neurosurgeon. Stout [5] reported 50 cases. Pain was present in only 13, and in 19 cases the mass was tender. Sensory disturbance and paresthesia over the distribution of the nerve may be noted.

Figi [6] stated in 1933 that several cases of solitary neurofibroma arising in the submaxillary region had been seen at the Mayo Clinic. Stout reported that 10 cases of neurofibroma of the sublingual area had been recorded, to which he added 2 more. Coates,[7] in 1941, reported a case involving the sublingual area.

We have recently observed a case of solitary neurofibroma of the submaxillary region which we believe is worthy of reporting because of the rarity of a tumor of this type occurring in this location.

REPORT OF A CASE

A 63 year old woman was seen in my office on Oct. 12, 1945. She offered a history of pain that had been present at the base of the tongue on the right side for the past three months. Examination revealed a firm encapsulated mass, elliptic in shape, measuring approximately 2 by 3 cm., and somewhat nodular, in the right submaxillary region close to the mucous membrane of the floor of the mouth. Clear fluid of normal viscosity was expressed from Wharton's duct. The remainder of the examination of the ears, nose and throat gave essentially negative results. General examination revealed nothing of significance.

On October 29, with the patient under combined local and intravenous "pentothal sodium" anesthesia, the tumor was removed through an external approach. An incision 4 cm. long was made in the submaxillary area, paralleling the horizontal ramus of the lower mandible. By blunt dissection, the submaxillary gland was exposed and retracted laterally, bringing into view the tumor. The assistant's finger was inserted into the mouth, to force the tumor mass into the submaxillary triangle, from which, by blunt dissection, it was delivered *in toto*. A Penrose cigaret drain was placed in the wound, and the incision was closed with subcutaneous catgut and 00000 "zytor."

The specimen consisted of an encapsulated mass, 2 by 3 cm. in diameter, of uniform firm consistency except for small central areas of softening.

Microscopic examination of routine hematoxylin-eosin preparations revealed an encapsulated neoplasm consisting of interlacing bundles of spindle shape cells which in some areas showed a tendency toward palisading. In the central portions

5. Stout, A. P.: The Peripheral Manifestations of the Specific Nerve Sheath Tumor (Neurilemma), Am. J. Cancer **24**:751-796 (Aug.) 1935.

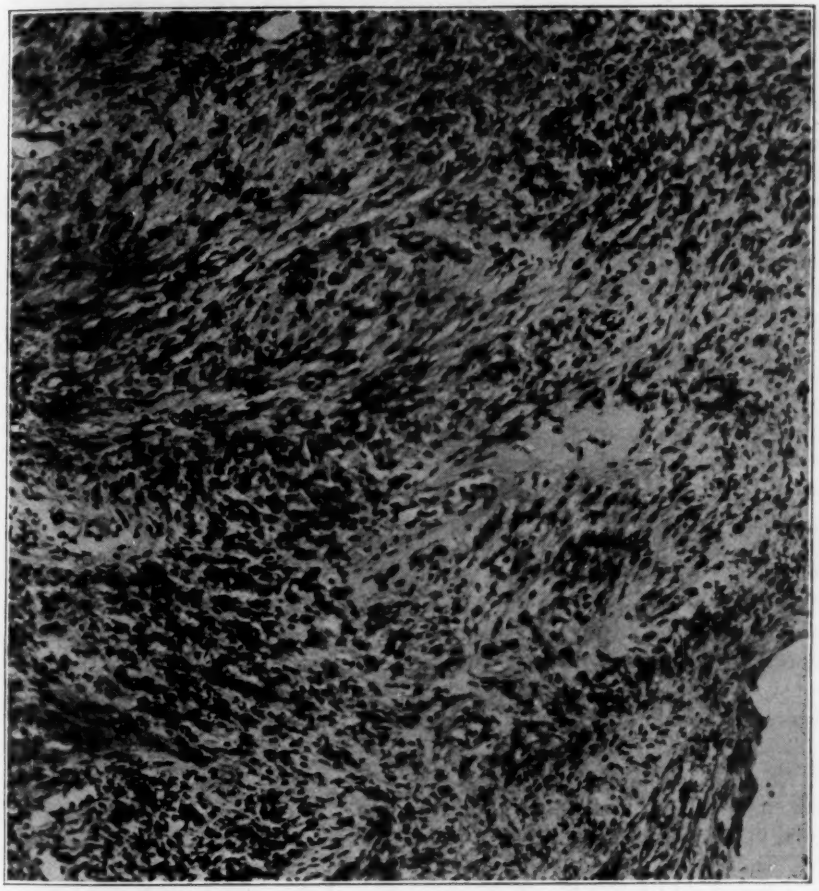
6. Figi, F. A.: Solitary Neurofibroma of the Pharynx, Arch. Otolaryng. **17**:386-389 (March) 1933.

7. Coates, G. M.: Schwannoma of the Mouth, Arch. Otolaryng. **34**:1166-1167 (Dec.) 1941.

of the neoplasm there were areas of edema and a few pigment-laden macrophages which were present as the result of old trauma, circulatory disturbance and hemorrhage (figure).

The patient made an uneventful recovery. Postoperative examination revealed complete loss of sensation over the whole right side of the tongue. One year after removal of the tumor examination revealed no evidence of recurrence. The numbness on the right side of the tongue was still present.

Preoperatively the patient appeared to have a mixed tumor of the submaxillary gland. Following microscopic studies of the removed tumor, closer questioning



Photomicrograph of solitary neurofibroma of the submaxillary region; × 160.

revealed that the patient had been noting gradual progressive loss of sensation over the whole right side of the tongue for the past year.

COMMENT

A case of solitary neurofibroma of the submaxillary area is presented. Such a tumor located in this area is rarely diagnosed preoperatively as neurinoma or neurofibroma, but is most frequently diagnosed as being a mixed tumor. However, sensory or motor changes should lead one to suspect a tumor of nerve origin.

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New Instruments and Technics

TREATMENT OF OTITIS EXTERNA WITH SULFANILAMIDE OINTMENT

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WHILE stationed with the Armed Forces in India, I had occasion to treat a large number of infected external auditory canals. That country was extremely hot, humid and dusty, which increased the severity and the prevalence of all infections of the skin and made their control of major importance and at the same time more difficult of achievement. After all the usual methods of treatment had been tried, with disappointing results, a new method was found which yielded the quickest and most lasting results. This consisted in scrupulous cleansing of the canal with cotton-tipped applicators dipped in hydrogen peroxide, then thorough drying of the canal with cotton applicators and liberal application of 5 per cent sulfanilamide ointment, all surfaces of the canal and drum being covered with this. Pain, which was commonly present, generally subsided after the first treatment. In nearly all cases, itching and all signs of irritation were cured by daily treatments continued for a period of seven to twelve days; a few patients required longer treatment of three to four weeks with gradually lengthened intervals between visits. A small percentage of patients showed a recurrence; this responded to reinstitution of the local treatment. Some patients presented the appearance of severe cellulitis and edema of the canal with only a filiform opening in the canal or no opening at all. These patients were hospitalized and given full doses of sulfonamide compounds or penicillin and moist heat locally until the cellulitis subsided; then they were discharged and followed in the clinic. Occasionally an external canal would appear to be perfectly well after treatment; yet the patient would complain of itching; in cases of this type, wiping of the canals with an applicator soaked in meta-cresylacetate resulted, after two or three applications, in cessation of the itching.

This method of treatment was found to be beneficial in cases of mold infection as well as in those due to fungi and bacteria. The ointment containing sulfanilamide in concentration of 5 per cent was chosen empirically; later it was discovered that Senturia and Wolf [1] had reported that, of all sulfonamide compounds, only sulfanilamide had fungistatic effects on surface colonies of Aspergillis, Penicillium and Mucor besides the ordinary bacteriostatic power of the other sulfonamide compounds.

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From the Massachusetts Memorial Hospitals.

1. Senturia, B. H., and Wolf, F. T.: Treatment of External Otitis: II. Action of Sulfanilamide on Fungi Isolated from Cases of Otomycosis, Arch. Otolaryng. **41**:56 (Jan.) 1945.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

PERORAL ENDOSCOPY

A Review of the Literature for 1946

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CONGENITAL ANOMALIES OF THE TRACHEOBRONCHIAL TREE

CONGENITAL anomalies of the tracheobronchial tree unquestionably are more common than medical literature would indicate. Many cases terminate fatally before studies can be instituted, and never are recognized unless necropsy studies are permitted. In addition, certain congenital anomalies produce minimal clinical signs and symptoms and often are not detected. Where the roentgenogram and the bronchoscope are employed more frequently in the diagnosis of bronchopulmonary disorders, anomalies of the latter group are recognized.

Pulmonary Anomaly.—Field [1] reported a series of 14 cases of pulmonary anomalies which were grouped as follows: 5 cases of absence or permanent underdevelopment of one lung, i. e. agenesis, aplasia or permanent hypoplasia; 6 cases of displacement of the heart and mediastinum with slow readjustment, probably a temporary hypoplasia, and 3 cases in which a localized opacity was shown on the roentgen film. The last-mentioned cases were interpreted as instances of hypoplasia or of atelectasis of part of a lung with no bronchial communication. In a number of these cases bronchoscopy and bronchography were performed for corroboration of the diagnosis.

Mitchell [2] reported the following cases:

A child 2 years of age with an undiagnosed lesion of the right side of the chest became dyspneic and cyanotic immediately on aspirating some partially masticated peanuts and some chewing gum into the tracheobronchial tree. Cyanosis and dyspnea persisted, and the child died within twenty minutes after aspiration

1. Field, C. E.: Pulmonary Agenesis and Hypoplasia, Arch. Dis. Childhood **21**:61 (June) 1946.

2. Mitchell, H. E.: Agenesis of the Right Lung with Death Following Aspiration of Foreign Bodies into the Left Lung, Ann. Otol., Rhin. & Laryng. **55**:609 (Sept.) 1946.

of the foreign bodies, so that no bronchoscopic or other procedure could be carried out.

At autopsy the right lung was completely absent, and there was a bronchus ending blindly. There was neither rudimentary right lung tissue nor vessels. When the left bronchus was opened, two foreign bodies, a masticated mass of peanuts and chewing gum, were found.

A discussion of reported cases of agenesis of a lung is included in the article.

Pierson [3] reported a case of aplasia of the lung:

A positive diagnosis was made, following roentgen study, bronchoscopy and bronchography, when the patient was 8 months of age. The differential diagnosis of congenital absence of a lung is difficult. Pneumonia, hydrothorax, paralysis of the diaphragm, diaphragmatic hernia and foreign body lodged in a bronchus must be considered. The usual roentgen interpretation is massive or fetal atelectasis.

The bronchoscopic examination was carried out with a 3.5 mm. bronchoscope. The trachea was deviated to the right. There was no evidence of a carina or of a right bronchus. The left bronchus was normal. Later iodized oil was introduced through a tracheal catheter without complications, and this revealed a normal left bronchus, there being no evidence of bifurcation.

At the time of the report the patient had been observed on two occasions for an acute infection of the respiratory tract, each with complete recovery. At the time that the report was made the patient was convalescing from measles.

TRACHEOBRONCHIAL APPLICATION OF PENICILLIN

That penicillin is of value in the treatment of bronchopulmonary suppuration is recognized, but it must be emphasized that it is an aid rather than a substitute. This applies particularly to those conditions in which drainage has to be provided through the air passages or by surgical intervention. As in the case of the sulfonamide compounds, which were generally employed and received generous acclaim for a time, so also will penicillin be tried. Pharmacologic and clinical reports indicate to date that penicillin will earn a place in the treatment of certain tracheobronchial infections.

In a discussion of this subject Andrews and Holinger [4] summarized the results obtained with penicillin aerosol in 40 cases of bronchopulmonary disease associated with infection. The great majority of the patients were improved. Penicillin is particularly suited for topical application because it is readily soluble in water, isotonic solution of sodium chloride and body fluid, it does not readily diffuse and its potency is not affected by organic detritus. The reduction of the amount and the improvement of the purulent bronchial secretions of bronchiectasis make the instillation of penicillin solution an important adjunct of the preoperative preparation of the patient. The decrease of the amount

3. Pierson, W. M.: Aplasia of the Lung, Ann. Otol., Rhin. & Laryng. **55**: 604 (Sept.) 1946.

4. Andrews, A. H., Jr., and Holinger, P. H.: Penicillin Therapy in the Trachea and Bronchi, Ann. Otol., Rhin. & Laryng. **55**:617 (Sept.) 1946.

of secretion lessens the danger that this may spill over into the other lung or other lobes.

Penicillin solution given in nebulized form has appeared to be more effective in some cases than penicillin solution administered intramuscularly. Avoidance of injection, self medication and home treatment are aspects of penicillin therapy deserving consideration.

Insufficient experience with prolonged treatment renders it difficult to evaluate the comparative effectiveness of penicillin aerosol in acute and in chronic bronchopulmonary disease. The incidence of reactions following the use of penicillin aerosol may be as high as 15 per cent, but reactions constituting a serious threat to patients have not been observed.

In the experience of Hanks [5] the best results obtained in the treatment of infections of the respiratory tract have been secured by employing a saline solution of penicillin with a strength of 500 units per cubic centimeter. He has also found that if the solution is kept in a refrigerator it will not deteriorate rapidly but will remain potent for at least four months longer. The method of nebulizing the solution is simple. A DeVilbiss atomizer, no. 40, is connected by a rubber tube to an oxygen tank with a flow meter and a humidifier, and 2 cc. of penicillin is placed in the glass nebulizer. The oxygen flow is set at 4 liters. The patient is instructed to hold the nebulizer between the teeth and breathe through the mouth. The treatment usually takes twenty minutes and is given once a day. In a group of 34 patients he found that 94 per cent received appreciable benefit. In those with acute laryngitis, tonsillitis and bronchitis the results were startling. One to three treatments gave complete relief from fever. Streptococcic pneumonitis and even virus pneumonia also responded to this method of treatment, even after parenteral injection of penicillin solution had failed.

Nebulized penicillin solution was given to 43 patients who had bronchiectasis, bronchitis or asthma by Southwell.[6] In the bronchiectatic ones there was no improvement, and this was attributed to the poor entry of air in the region of the disease, the multiplicity of the infectious organisms and the extensive pulmonary damage.

In the cases of bronchitis of short duration the results were more encouraging. Of 6 patients treated, 5 were apparently cured and 1 was much improved. In 5 patients with chronic suppurative bronchitis there was no improvement. It would seem, therefore, that any measure that can cut short attacks of bronchitis, which exert a permanent damaging effect on bronchial epithelium with accompanying peribronchial fibrosis, would be of great importance in therapy.

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5. Hanks, R. J.: Nebulized Penicillin in the Treatment of Respiratory Infections, Dis. of Chest **12**:242 (May-June) 1946.

6. Southwell, N.: Inhaled Penicillin in Bronchial Infections, Lancet **2**:225 (Aug. 17) 1946.

In chronic bronchitis and bronchitic asthma it appears that the more dry the bronchi the greater is the degree of improvement to be expected. The possibility of combining sulfonamine therapy with inhalation of penicillin aerosol in dealing with penicillin-resistant organisms in certain of these cases was suggested.

Studies were carried out by Humphrey and Joules [7] to find a suitable route, dose and interval of time for penicillin treatment of chronic infection of the lungs and bronchi. The good results obtained with intramuscular injections in acute bronchopulmonary infections have been in striking contrast to the poor results obtained in chronic conditions, and it was decided to explore the possibilities of inhalation of the aerosol.

Studies of sputum made after intramuscular injections revealed that while penicillin was found in significant amounts in the majority of samples of sputum in cases of lobar pneumonia, in those of pulmonary abscess, chronic bronchitis and bronchiectasis it was only occasionally detected. Penicillin administered as a fine mist could be detected in the sputum for six hours or more after inhalation of a single dose of 15,000 units. The exact time varied with the dose inhaled.

In a study of 80 patients treated by inhalation it was found that 46 were much improved and 17 moderately improved. While in those with acute and subacute conditions which responded to treatment recovery was usually complete, those whose disease was more chronic were relieved but not permanently cured. Preoperative and postoperative treatment of patients with chronic pulmonary infections who were submitted to operation was associated with a low complication rate.

Observations made by Morse [8] on the use of a penicillin spray produced by a hand atomizer suggested that it is effective in various infections of the respiratory tract. The method is easy, inexpensive and quite as generally applicable as sulfonamide therapy, yet is not dangerous. While his series of cases, totaling 25, is not large, the results warrant further trial in a large number of cases. He found that penicillin spray generated by hand or bulb atomizer was effective against many infections of the respiratory tract, including those of the nasopharynx. The penicillin spray generated by an atomizer is a cheap, safe painless agent which may be applied by home users and by untrained personnel.

In a group of 14 patients with bronchopulmonary disease treated with penicillin aerosol, Fullerton and Shane [9] administered 25,000 units

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7. Humphrey, J. H., and Joules, H.: Penicillin Inhalation in Pulmonary Disease, Lancet **2**:221 (Aug. 17) 1946.

8. Morse, F. W.: Penicillin Spray by Bulb Atomizer in Respiratory Infections, J. A. M. A. **132**:272 (Oct. 5) 1946.

9. Fullerton, C. W., and Shane, S. J.: Treatment of Acute and Chronic Pulmonary Disease with Penicillin Aerosol, Canad. M. A. J. **54**:535 (June) 1946.

every three hours. Lobar pneumonia responded in 4 cases, but virus pneumonia appeared to be uninfluenced. A pulmonary abscess of over four months' duration was cured after six and one half weeks of therapy, but another chronic pulmonary abscess did not respond satisfactorily; stenosis of a bronchus was discovered and this, interfering with drainage, probably also interfered with entrance of the penicillin.

In 3 patients bronchiectasis, and in 3 chronic bronchitis, of long duration in all, did not respond satisfactorily. In but a single patient was a reasonably favorable result secured. It is possible that failure to secure beneficial results was due to the presence of resistant gram-negative organisms, which were found in the sputum of 4 of the 5 other patients. It is their opinion that if favorable results are not obtained within one week, this therapy should be discontinued.

POSTOPERATIVE PULMONARY COMPLICATIONS

The problems of traumatic surgery of the chest in the military theater are identical with those encountered in ordinary civilian experience. Pulmonary atelectasis developing after trauma of the chest will, if unrelieved, result in pneumonitis.

Samson and Brewer [10] emphasized that with any degree of obstruction of a bronchus the treatment should be aimed at improving the impaired tracheobronchial drainage as rapidly as possible. Pain resulting from concussion of a thoracic wall or fracture of ribs is a common cause of inability to breathe deeply or to cough and raise sputum. Nerve block for the control of pain of the thoracic wall has been found useful, particularly when this produces limitation of respiration and cough. If simple measures are not adequate, mechanical aspiration of the content of the tracheobronchial lumen should be resorted to and either a tracheobronchial catheter or a bronchoscope may be used. Each has its advantages, and there are but two clearcut indications for the one rather than the other. Bronchoscopy may be followed by repeated catheteral aspiration, for the technic and the equipment for catheteral suction are simple and usually readily available. Since one may practice this without anesthesia, the catheter can be more easily used in an emergency. When it is probable that frequent aspirations will be necessary, catheteral suction should probably be performed from the beginning.

Bronchoscopy is a highly technical procedure and should be performed by one especially trained in this technic. Bronchoscopic aspiration is more efficient than catheteral suction, since it is done under direct vision, and all visible bronchi may be aspirated by employing straight or curved suction tubes. Bronchoscopy is the treatment of choice when

10. Samson, P. C., and Brewer, L. A.: Principles of Improving Inadequate Tracheo-Bronchial Drainage Following Trauma to the Chest, J. Thoracic Surg. **15**:162 (June) 1946.

the obstruction is due to particulate material, blood clots and plugs of thick mucus. In a case of unilateral massive collapse, immediate bronchoscopic aspiration is preferable to a more conservative regimen. It is indicated in partial tracheal obstruction and also should be employed when an unconscious patient aspirates vomitus, particularly postoperatively, before he leaves the operating room. Postoperative vomiting is observed more often in military than in civilian surgical patients, and the necessity to aspirate vomitus from the tracheobronchial tree would therefore be a more frequent complication.

A majority of the postoperative pulmonary complications are directly related to tracheobronchial retention of secretions or to aspiration of foreign material. Conklin [11] recommended that in prevention the first consideration should be given to the preoperative condition and preparation of the patient. The presence of an acute infection of the upper respiratory tract should call for several weeks' postponement unless the indication for surgical intervention is urgent. Oral hygiene likewise calls for preoperative attention, as it has been shown that after surgical treatment fewer pulmonary infections develop in edentulous patients than in others. Dentures and teeth should be examined before and after operation, and sponges, instruments and pieces of tissue should be carefully checked when one is operating about the mouth or the throat.

The choice of preoperative medication and of anesthesia should be such as to assure early return of the cough reflex and of consciousness. With this in mind meperidine hydrochloride ("demerol hydrochloride") is preferable to morphine sulfate and scopolamine hydrobromide. Clearing the tracheobronchial tree of secretion is important, and the patient should be encouraged to cough at frequent intervals. Analgesic drugs should be used to reduce the pain due to cough but in doses small enough so that the cough reflex will not be eliminated. Secretions which cannot be got rid of by the ordinary methods must be aspired either by employing a catheter, preferably passed pernasally, or a bronchoscope if this method fails.

Pulmonary complications have been the most serious cause of postoperative morbidity. Gordon [12] expressed the opinion that in all cases "postoperative pneumonia" develops on a basis of unrelieved pulmonary atelectasis. The greater proportion of postoperative patients suffering from atelectasis will remove the obstructing secretions from the bronchial tree by deep breathing and forced coughing and then will reexpand the collapsed segment of lung. When this cannot be accomplished within

11. Conklin, W. S.: Postoperative Pulmonary Complications: Prevention and Treatment, Northwest Med. 45:494 (July) 1946.

12. Gordon, R. A.: Bronchoscopy in the Treatment of Pulmonary Atelectasis, Canad. M. A. J. 54:6 (Jan.) 1946.

a reasonable period, preferably a few hours, the obstruction should be removed. This may be done efficiently and with little discomfort to the patient by aspirating the secretions under direct vision through the bronchoscope.

The bronchoscope has been found useful in providing suction drainage of the tracheobronchial tree for postoperative patients, for patients who are unconscious or who are suffering from injury of the nervous mechanism controlling cough and for those who have aspirated blood or other foreign material. If aspiration is delayed, it may be found impossible to fully expand the collapsed segment of lung immediately, and the danger of a superimposed pneumonic process may be faced.

In a discussion of the surgical management of abdominal wounds, Snyder [13] reported that the incidence of atelectasis was higher subsequent to laparotomy than after thoracotomy although in many instances of the latter the pulmonary secretions were routinely aspirated. He believed that the number of cases in which atelectasis followed laparotomy would have been materially reduced if there had been a routine immediate postoperative catheteral or bronchoscopic aspiration of the tracheobronchial tree.

Postanesthetic Bronchopneumonia.—In a study of the bronchopneumonia observed in 20 patients on an obstetric service, Hartzell and Mininger [14] concluded that the chief cause was the aspiration of vomited gastric contents. Possible contributing factors were the preanesthetic medication, favoring suppression of the cough reflex, the prolonged gastric evacuation in labor and the fluidity of the gastric contents, favoring their intrabronchial dissemination.

Anesthesia had been induced in these cases with ether, which was administered usually by the open method and was preceded by varying quantities of barbiturates and other premedication drugs.

The bronchopneumonia was discovered in almost all cases by means of roentgenograms of the chest made to investigate the significance of slight fever or bronchopulmonary physical signs following delivery. While in no instance was the pneumonia of sufficient clinical severity to require the use of chemotherapy, the employment of this did not affect the course of the disease in any case in which it was administered. Postural drainage and catheteral or bronchoscopic aspiration of the bronchial tree are recognized methods of treating patients who aspirate vomitus during anesthesia. Preoperative induced emesis when carefully executed might prevent the postanesthetic vomiting and aspiration of foreign materials.

13. Snyder, J. M.: Surgical Management of War Wounds of the Abdomen, Am. J. Surg. **72**:331 (Sept.) 1946.

14. Hartzell, H. C., and Mininger, E. P.: Bronchopneumonia Following Ether Anesthesia in Obstetrics, Surg., Gynec. & Obst. **82**:427 (April) 1946.

Pulmonary complications appear more common after general anesthesia than after spinal anesthesia unless a careful prophylactic regimen is observed before, during and after operation. In a study of the incidence of postoperative atelectasis and pneumonia, Dripps and Deming [15] found that among 250 surgical patients the incidence was 11 per cent when inhalation, and 4.2 per cent when spinal, anesthesia had been used. After the institution of a positive prophylactic program to be carried out prior to the administration of inhalation anesthesia for any operation involving the upper part of the abdomen, they discovered that the incidence of respiratory complications following spinal anesthesia remained unchanged but that the incidence following general anesthesia was reduced to 4.1 per cent.

Among the preoperative measures was that of postponing surgical treatment, except in case of emergency, for one or two weeks when a patient had an infection of the upper respiratory tract. Patients with chronic disease of the respiratory tract were urged to cough up all secretions possible, and when this did not appear to clear the tracheobronchial tree, aspiration was done bronchoscopically.

During the operative procedure anesthesia was maintained on the lightest plane compatible with the surgical procedure. Every effort was made to prevent aspiration of secretions, particularly of regurgitated gastric contents.

During the postoperative period the patient's position was changed completely at least hourly. Secretions were aspirated from the nose and the mouth by catheter as often as necessary. The quantity of narcotic drug was limited. The patient was encouraged to cough. Carbon dioxide was given by inhalation as indicated. These authors expressed the opinion that a postanesthetic observation room staffed by trained personnel and equipped to handle all emergencies should constitute a part of all surgical services.

Investigation of the etiologic factors causing postoperative atelectasis and pneumonia revealed that the incidence was higher in men, in smokers, in persons who had undergone operations involving the upper part of the abdomen, in patients with chronic or acute infections of the respiratory tract and also with increasing age of the patient and with increasing length of operation.

Eight cases of pulmonary atelectasis observed in connection with a series of 85 operative procedures involving the upper urinary tract led Faulconer and his associates [16] to make a careful study of this problem. In every case the atelectasis occurred in the contralateral

15. Dripps, R. D., and Deming, M. V.: Postoperative Atelectasis and Pneumonia, Ann. Surg. **124**:94 (July) 1946.

16. Faulconer, A., Jr.; Gaines, T. R., and Grove, J. S.: Atelectasis During Operations on the Upper Urinary Tract, Anesthesiology **7**:635 (Nov.) 1946.

lung. The only common possible etiologic factor was the unphysiologic lateral position required for this type of operation. A wide variety of anesthetic agents and methods was used and seemed to have no important bearing on the postoperative pulmonary complications. None of the patients received prophylactic carbon dioxide–oxygen hyperventilation. In 6 of the cases bronchoscopic aspiration was performed as soon as the diagnosis of atelectasis was made. In 3 cases it was necessary to repeat this procedure. They suggested, as an important point in prophylaxis, that the patient's position be shifted to the side of operation at frequent intervals.

Mediastinal Cyst.—Preliminary to doing a tracheotomy in an infant aged 3 months who was dyspneic, Tucker [17] inserted a bronchoscope and found a compression of the posterior wall of the trachea producing expiratory collapse. This compression extended down to the level of the bifurcation. Tracheotomy was done, with temporary relief of dyspnea; later, however, dyspnea increased, and the mass appeared to be growing larger. The patient died one week after being admitted to the hospital, of pulmonary complications.

At postmortem examination a mediastinal cyst was found, probably arising from the trachea, which produced compression of the trachea and the left main bronchus. The esophagus was displaced posteriorly. No direct connection of cyst and trachea or esophagus could be demonstrated.

TUMORS AND OTHER INVOLVEMENTS OF THE TRACHEOBRONCHIAL TREE

Adenoma.—In a review of the literature concerning adenoma of the bronchus, Gonzalez Loza [18] discussed the histologic structure, the histogenesis and the question of whether this tumor is malignant. Two cases of bronchial adenoma are reported.

One of the patients, a woman aged 48 years, complained of fever, dyspnea, pain of the right side of the chest and loss of weight of one month's duration. At bronchoscopy a small tumor observed in the right inferior bronchus was readily removed with forceps.

The second patient, a girl 14 years of age, had fever, night sweats, repeated hemoptysis and loss of weight. Tuberculosis was suspected. Roentgen examination revealed atelectasis of the lower part of the right lung. At bronchoscopy a reddish tumor, which bled freely and completely blocked the bronchus, was found attached by a wide pedicle to the lateral wall of the right bronchus beyond the orifice of the upper lobe bronchus. This was completely extirpated by endo-

17. Tucker, G.: Congenital Cyst in the Mediastinum Producing Compression of the Lower Trachea and Esophagus, Ann. Otol., Rhin. & Laryng. **55**:693 (Sept.) 1946.

18. Gonzalez Loza, M.: Bronchial Adenoma, Rev. argent. de bronco-esofagol. **2**:58 (July) 1946.

scopic means. There has been no recurrence during the four years following removal.

Lipoma.—Benign bronchial tumors may produce complete bronchial obstruction and often fatal suppuration of the lung tissues distal to the occlusion. While their occurrence is not common, with more frequent bronchoscopy and routine roentgen studies of the chest more of the benign tumors are being diagnosed clinically. Watts [19] and his associates reported a case of lipoma of the bronchus; the literature was reviewed, and the occurrence of fatty tumors of the lung was discussed.

In the case reported, a diagnosis of tuberculosis had been made, and the patient was treated in a sanitarium for one year, with some improvement, although cough, fever and night sweats continued unabated. The sputum was repeatedly negative for tubercle bacilli when examined by the writers; roentgenograms revealed a granular process involving the upper lobe of the left lung. Bronchograms were made, but the upper lobe could not be visualized. At bronchoscopy, purulent secretion was found bilaterally, but no obstructing lesion could be seen. Since no definite diagnosis could be made and stenosis of the upper lobe bronchus of the left lung appeared to be present, an exploratory thoracotomy was performed. The upper lobe of the left lung was found atelectatic. It was decided, therefore, to perform lobectomy, and the upper lobe was removed. The patient's postoperative course was uneventful, and he was discharged from the hospital fourteen days postoperatively.

Pathologic study revealed an encapsulated tumor 2 cm. in diameter in the main bronchus of the upper lobe of the left lung, attached by a narrow pedicle and completely occluding the lumen. A diagnosis of lipoma was made.

Bronchogenic Carcinoma.—In 100 consecutive cases of primary pulmonary carcinoma examined by Lindskog [20] 65 patients were found inoperable when first admitted. Three refused treatment. Surgical exploration was performed on 32 patients, and in 20 of these the tumors were not found suitable for resection. Of the 12 patients whose tumors were resectable, 10 were treated by pneumonectomy, and in 2 lobectomy was performed. At the time of report 3 patients had survived 2.5 to 5.5 years after successful resection of their tumors.

It was of interest to note that the upper lobes, together with the stem bronchi above the orifices of the upper lobe bronchi, were involved in 69 per cent of cases. Tissue yielding a positive diagnosis was obtained from 82 patients, from 77 during life and from 5 at autopsy, but of these only 28 had revealed positive evidence of carcinoma at bronchoscopy. In 20 of the 32 cases in which exploration was done, the operation was approached without a positive biopsy and with only

19. Watts, C. F.; Claggett, O. T., and McDonald, J. P.: Lipoma of the Bronchus: Report of a Case, J. Thoracic Surg. **15**:132 (April) 1946.

20. Lindskog, G. E.: Bronchogenic Carcinoma, Ann. Surg. **124**:667 (Oct.) 1946.

a presumptive clinical diagnosis. In 10 of the 12 resections this also proved to be the case.

In a series of 448 cases proved to be instances of carcinoma of the lung, reviewed by Claggett,[21] there was revealed in 70 to 75 per cent a lesion occurring in a bronchus accessible to bronchoscopic examination and biopsy. Claggett stated that bronchoscopy is a valuable diagnostic aid and that it should be carried out in every case in which the possibility of carcinoma of the lung is suggested. It not only furnished accurate information about the pathologic nature of the bronchial lesion but also was of value in determining the exact site of the lesion and thus providing important information regarding the operability. In at least 25 to 30 per cent of the cases the lesion was not accessible to bronchoscopic biopsy, and in these, therefore, the carcinoma would have become inoperable if positive proof of the diagnosis had been demanded before the patient was accepted for operation. He emphasized the importance of exploratory thoracotomy.

In spite of improvements of diagnosis and of surgical treatment, the death rate from carcinoma of the lung remains appallingly high. The two most important factors responsible are delay on the part of the patient in consulting a physician and delay on the part of the physician in arriving at a correct diagnosis. While bronchoscopy is undoubtedly the best single procedure for diagnosing lesions of the trachea and larger bronchi, it is of little positive value in the diagnosis of the peripherally situated tumors. On the basis of the literature concerning the operability of bronchogenic carcinoma it appears that in the cases in which the carcinoma can be diagnosed bronchoscopically it is more often inoperable while in those in which it is beyond the range of bronchoscopic vision it more often can be successfully resected.

Herbut and Clerf[22] studied bronchial secretions removed bronchoscopically and on the basis of their findings concluded that carcinoma can be positively diagnosed in an additional number of cases over and above the number in which it is diagnosed by biopsy. In 30 consecutive cases of primary pulmonary carcinoma the bronchial secretions were stained by the Papanicolaou technic and cancer cells were demonstrated in 22, or 73 per cent. In the same series a positive bronchoscsopic biopsy specimen was secured in 11 cases, or 36 per cent. The cytologic method is not presented as a substitute but as an aid to the means already employed in the diagnosis of pulmonary carcinoma. It is particularly useful in those cases in which the tumor is located at the periphery of the lung or in an upper lobe beyond the range of bronchoscopic vision.

21. Claggett, O. T.: Tumors of the Lung, South. M. J. **39**:138 (Feb.) 1946.

22. Herbut, P. A., and Clerf, L. H.: Bronchogenic Carcinoma Diagnosis by Cytologic Study of Bronchoscopically Removed Secretions, J. A. M. A. **130**: 1006 (April 13) 1946.

Further cytologic studies of bronchial carcinoma made by Clerf and Herbut [23] corroborated their earlier view, namely, that this method affords additional aid in the diagnosis of carcinoma in those cases in which the bronchus cannot be visualized bronchoscopically. In a group of 57 cases proved to be instances of bronchogenic carcinoma, the cytologic diagnosis was made in 47 cases (82.4 per cent). A diagnosis was made by bronchoscopic biopsy in 24 cases (42.1 per cent) and by anatomicopathologic changes in 15 cases (26.3 per cent), a total of 39 bronchoscopic diagnoses (68.4 per cent). While the difference between the percentage rates—82.4 for the cytologic diagnosis and 68.4 for the bronchoscopic diagnosis—is impressive, of more importance is the group in which bronchoscopy gave a negative, and cytologic examination a positive, diagnosis. In all of the latter the diagnosis was corroborated either at surgical exploration or at autopsy. It is believed that when more frequent roentgen examinations are made, and all patients whose roentgenograms show questionable shadows are subjected to bronchoscopy, so that secretions may be secured for cytologic study, the diagnosis of bronchogenic carcinoma will be made earlier, more patients will be found suitable for surgical treatment and the prognosis of bronchogenic carcinoma will become more hopeful.

Cystic Disease of Lungs.—In a report based on a study of 22 cases of cystic disease of the lung, Dickson and his associates [24] emphasized the protean nature of the symptoms, which are dependent largely on the size of the cyst, its location and the presence or the absence of a bronchial communication. While an accurate diagnosis is largely dependent on adequate roentgenologic examination of the thorax, bronchoscopy has definite value, particularly if the patient is to be treated surgically, to rule out the possibility of other bronchial lesions. Occasionally an accurate diagnosis can be arrived at only by exploratory thoracotomy.

Boeck's Sarcoid.—The cause of Boeck's sarcoid, a chronic systemic disease which resembles tuberculosis, leprosy and other members of the granuloma family, is unknown. The disease is as protean in its manifestations as are tuberculosis and syphilis. The diagnosis usually is based on the correlation of the histopathologic picture and the clinical syndrome. Microscopic examination of tissue obtained for biopsy or at postmortem examination has been the basis for the diagnosis in most of the reported cases.

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23. Clerf, L. H., and Herbut, P.: Diagnosis of Bronchogenic Carcinoma by Examination of Bronchial Secretion, Ann. Otol., Rhin. & Laryng. **55**:646 (Sept.) 1946.

24. Dickson, J. A.; Claggett, O. T., and McDonald, J. R.: Cystic Disease of the Lungs and Its Relationship to Bronchiectatic Cavities: A Study of Twenty-Two Cases, J. Thoracic Surg. **15**:196 (June) 1946.

In the case reported by Olsen [25] the diagnosis was made by way of bronchoscopic examination and biopsy. The mucosa of the lateral wall of the right main bronchus had an unusual nodular appearance. The pathologist made a diagnosis of chronic granuloma resembling tuberculosis. The patient, a 47 year old woman, complained of difficulty in swallowing and talking and huskiness of voice. There was found paralysis of the right side of the larynx, the right constrictor muscles of the pharynx and the right side of the soft palate. Routine laboratory tests were negative. Roentgen studies of the lungs revealed changes in the upper field of the right lung, suggesting pulmonary tuberculosis.

Boeck's sarcoid is a condition which must be kept constantly in mind by those interesetd in thoracic disease and bronchoscopy. Although this condition is most commonly confused with pulmonary tuberculosis and Hodgkin's disease, it also must be distinguished from primary or metastatic cancer of the lung, leukemia, pulmonary fibrosis, bronchiectasis and fungous disease of the lung.

Atrophic Tracheobronchitis.—Cases of marked localized keratosis unassociated with atrophic changes of the mucosa of the air passages have been reported. The case of atrophic tracheobronchitis with metaplasia reported by Brethauer and Culleton [26] is unique in that a careful search of American literature has revealed no other report of a combination of all the lesions described. In their case there was long-standing rhinitis with ozena and the typical gross findings of atrophic laryngotracheobronchitis. In addition there was microscopic evidence of metaplasia of the epithelium with areas of ulceration, marked keratosis, hyperplasia of mucous glands, hypertrophy of the smooth muscle, increased connective tissue with chronic inflammation, submucosal and areas of new bone formation degeneration of the cartilage.

The patient, a man aged 40 years, gave a history of chronic rhinitis with crust formation and fetid odor of ten to twelve years' standing. He was admitted because of severe almost intractable dyspnea, orthopnea and paroxysmal productive cough. Grossly there were crusts in the nose, the larynx and the trachea, and it was necessary to remove the latter with forceps. Symptoms soon recurred and became progressively worse. The patient ultimately died twenty-four hours after the onset of severe dyspnea, which could not be relieved. The tracheal wall was found markedly thickened, and immediately below the thyroid cartilage the lumen was only 10 mm. in diameter. On section the epithelium here was entirely of a stratified squamous variety with marked keratinization.

A case of cicatricial stenosis of the trachea occurring in a boy who fourteen years previously had diphtheria requiring intubation was

25. Olsen, A. M.: Boeck's Sarcoid: A Brief Review and Report of a Case in Which Diagnosis Was Made By Bronschoscopic Examination and Biopsy, Ann. Otol., Rhin. & Laryng. **55**:629 (Sept.) 1946.

26. Brethauer, E. A., Jr., and Culleton, J. F.: A Case of Atrophic Tracheobronchitis with Metaplasia, Ann. Int. Med. **24**:505 (March) 1946.

reported by the Bences.[27] The dyspnea due to retention of secretions was alarming. A clinical diagnosis of tracheal stenosis was corroborated by roentgen study and endoscopic examination. A fibrous stricture, 4 by 5 mm., was found at the level of the second tracheal ring. Progressive dilation followed by electrocauterization resulted in complete recovery.

Broncholithiasis.—The diagnosis of broncholithiasis is made in the majority of cases after a broncholith has been expelled during a paroxysm of coughing. Hemoptysis, wheezing, dyspnea and at times pain are a not infrequent symptom complex. A case is reported by Barrett:[28]

The patient, a woman, had been ill for fifteen months with cough and recurrent fever. A diagnosis of pneumonia was made during the course of this illness. This responded to penicillin, but cough persisted. Later the symptoms recurred. During the course of pneumonia she expelled a small gritty mass which was thought to be a broncholith. When the patient was admitted to the hospital, there was found definite evidence of an atelectatic process, with infection involving the lower lobe of the right lung. At bronchoscopy a rough, irregular, grayish white calculus about 1 cm. in diameter was found in the right main bronchus obstructing the lumen, proximal to the orifice of the middle lobe bronchus. Following its removal, there was prompt improvement, and roentgen studies made three months later showed the right lung to be normal.

Broncholithiasis is often associated with tuberculosis but may occur in a patient with no evidence of tuberculous infection. Any persistent cough should suggest the presence of a broncholith, and a careful roentgenologic and bronchoscopic examination should be made. While dramatic results follow removal of the broncholith, its persistence, producing obstruction of the bronchus, will lead to bronchiectasis.

A majority of patients with broncholithiasis seek medical attention because of symptoms indicating bronchial obstruction or because of hemoptysis or expectoration of calculi. Zahn[29] reported a case:

The patient expectorated eight small, stony-hard, grayish white pieces of material varying in diameter from 2 to 5 mm. The sputum contained tubercle bacilli. Roentgen studies were considered to indicate that the chest was normal. A review of serial films made several years prior to the expectoration of the calculi and films made just after their expectoration revealed a definite decrease in the number of calcifications that previously had been observed in the right hilus. Several bronchoscopic examinations were performed, but the results were negative.

The diagnosis was based on the definite history of expectoration of broncholiths, the disappearance of the calcified lesions seen on serial roentgenograms and the smear and the culture of sputum which were shown to contain tubercle bacilli.

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27. Bence, A., and Bence, C. A.: Stenosis of the Trachea, Rev. argent. de broncho-esofagol. **2**:52 (July) 1946.

28. Barrett, J. H.: Broncholithiasis, Arch. Otolaryng. **44**:574 (Nov.) 1946.

29. Zahn, D. W.: Broncholithiasis, Am. Rev. Tuberc. **54**:418 (Oct.-Nov.) 1946.

Zahn reviewed the literature of broncholithiasis and found that the reported incidence of this condition is low when one considers the frequency with which calcification is observed in tuberculosis. This case demonstrates the potential dangers inherent in the so-called healed primary complex and again brings up for consideration the question whether calcified tuberculous lesions may harbor viable tubercle bacilli.

Bronchial Asthma.—The treatment of bronchial asthma is primarily a function of the internist and more specifically of the allergist. Since many other pathologic conditions may produce symptoms suggesting bronchial asthma, Lell [30] has again emphasized the importance of keeping them in mind. It is in these that the bronchologist may be of aid not only in diagnosis but in treatment. This is particularly true in regard to children, in whom a foreign body present in the air or the food passage may be entirely unsuspected—in fact, not even considered. In reviewing the records of 176 children admitted for bronchoscopic examination because of symptoms simulating asthma but not responding to the accepted plan of therapy it was found that there were 18 cases of foreign body of the respiratory tract, 5 of foreign body of the esophagus and 23 of other organic changes. Several typical illustrative cases are summarized in the article.

The characteristic bronchoscopic findings made in cases of allergic pulmonary disease are described, and the mechanism underlying the production of dyspnea and wheezing is discussed. The collapse of the larger bronchi and the trachea tends to increase the amount of retained secretion and adds considerably to the respiratory distress of the patient.

In the majority of patients who were in status asthmaticus when examined bronchoscopically there was noted a marked hemorrhagic and edematous appearance of the mucous membrane of the trachea and of the larger bronchi with presence of thick, tenacious secretion. In addition many showed marked collapse of the posterior tracheobronchial wall. In status asthmaticus which does not respond to medical treatment, bronchoscopic aspiration of the secretion may often be a life-saving measure. Oxygen administered through the bronchoscope during aspiration aids in relieving the dyspnea. The results secured with bronchoscopic treatment in 102 patients who were in status asthmaticus are tabulated.

One of the cardinal features of bronchial asthma is the narrowing of the bronchial lumen which is produced by spasm, edema of the mucosa or both. While this change usually is found in small bronchioles, it may involve one or more of the larger bronchi, producing partial or complete occlusion. In studying the bronchostenosis of asthma one therefore must appreciate the many causes of bronchial occlusion.

30. Lell, W. A.: Bronchoscopy as an Aid in the Diagnosis and Treatment of Allergic Pulmonary Disease, Arch. Otolaryng. **43**:49 (Jan.) 1946.

Mansmann and Osmond [31] emphasized the importance of roentgenologic studies of the chest in the diagnosis of bronchostenosis. It is important to secure films on inspiration and expiration or to examine the chest fluoroscopically or to do both. They emphasized the importance of complete allergic surveys if allergy is found to be an etiologic factor. When an acute infectious process is present, chemotherapeutic agents should be freely used. If the patients are under constant observation, bronchodilating drugs should be employed as long as symptoms are present, and if these become progressively worse or if there is roentgen evidence of a mediastinal shift suggesting atelectasis, bronchoscopy should be employed.

In a discussion of status asthmaticus, Cummings [32] reviewed the pathologic anatomy and the treatment with special reference to bronchoscopy and reported 4 illustrative cases. The most significant pathologic factors of status asthmaticus are the metamorphosis by which ciliated cells change to goblet cells and the atelectasis produced as mucus is propelled toward the larger airways.

The medical treatment of this condition requires a knowledge of many drugs that may be used to widen the airway, to aid elimination of mucus, to make it easy for oxygen to enter the alveoli, to rest the patient and to combat infection. Many of the patients are unable to get rid of secretions, and when roentgen studies and physical examination suggest the occurrence of patchy atelectasis, bronchoscopy is indicated. Cummings expressed the belief that, next to ridding the bronchus of secretions, the hyperventilation incident to deep inspiration during bronchoscopy is the most valuable feature of this procedure. Bronchoscopy, if carefully done, will do the patient no harm, and in most instances there will be a feeling of distinct benefit. It can be safely repeated as required.

In discussing the differential diagnosis of bronchial asthma Glaser [33] directed attention to the tragic mistakes that may be made if the physician does not realize that the physical signs and symptoms of asthma may be reproduced by the presence of an intrabronchial foreign body. This is especially true in infancy and childhood. The foreign body may almost always be diagnosed by roentgen examination, even if it is nonradiopaque, because of the local changes evoked by its presence. In case of any reasonable doubt concerning the diagnosis bronchosocpy is mandatory.

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31. Mansmann, J. A., and Osmond, L. H.: Complications of Bronchial Asthma and Their Association with Bronchostenosis, Pennsylvania M. J. **49**: 513 (Feb.) 1946.

32. Cummings, G. O.: Status Asthmaticus, Ann. Otol., Rhin. & Laryng. **55**:136 (March) 1946.

33. Glaser, J.: Differential Diagnosis of Bronchial Asthma in Infancy and Childhood, Ann. Allergy **4**:409 (Nov.-Dec.) 1946.

A survey of 250 cases of perennial bronchial asthma was made by Zoss and his associates.[34] It was concerned primarily with the bronchoscopic findings and infection of the respiratory tract. These cases were selected consecutively from a group of cases in which soldiers admitted to an Army general hospital because of asthma were given bronchoscopic examination in addition to the routine diagnostic study.

Bronchoscopy was utilized to assist in excluding conditions that simulate asthma and to demonstrate infection of the bronchi. It was noted that on many occasions information supplied by bronchoscopy was of considerable value in deciding the disposition of the case. When chronic bronchial infection was revealed bronchoscopically, the asthma usually could not be satisfactorily controlled, regardless of how favorable the case appeared otherwise. Consequently the occurrence of this complication was regarded as indicative of an unfavorable prognosis, and the asthma was evaluated accordingly.

Bronchoscopy revealed bronchial abnormalities in 89.6 per cent of the series. These were differentiated as chronic suppurative bronchitis in 49.2 per cent, chronic nonsuppurative bronchitis in 38.8 per cent and allergic bronchitis in 1.6 per cent.

Chronic bronchial infection was noted in a significant number of young soldiers whose asthma was of relatively short duration. Chronic suppurative infection of the respiratory tract was found in 73.2 per cent of all the patients.

Bronchography.—The diagnostic importance of bronchography is generally recognized, and a technic which is not too difficult or time consuming is desirable, so that bronchography may be practiced and rendered available to all patients who require it. The method recommended by Poppe[35] is outlined in great detail. Three fundamental principles are offered for obtaining a good bronchogram: Employ adequate anesthesia. Avoid delay between the injection of the oil and the taking of the roentgenogram. Maintain constant traction on the tongue until the film has been taken. A technic embracing the premedication, the anesthetizing of the pharynx and trachea, the posturing of the patient, the instilling of iodized oil into the trachea and the roentgenographic procedures is set forth in detail and should be carefully studied by any one contemplating bronchographic examination.

The use of bronchography has clearly demonstrated that bronchiectasis is far more common in the tuberculous than suspected. In a

34. Zoss, A.; Neidlinger, W. J., and Read, H. S.: Survey of Bronchial Asthma in Soldiers: Bronchoscopic Findings and Incidence of Respiratory Infection, J. Allergy **17**:87 (March) 1946.

35. Poppe, J. K.: A Simple and Practical Method of Obtaining Complete Bronchograms, Am. Rev. Tuberc. **54**:104 (Aug.) 1946.

study of 50 patients who had pulmonary tuberculosis, Boyer [36] was able to demonstrate the presence of bronchiectasis in 85 per cent of those with the fibroid type of involvement and in 36 per cent of those with fibrocaseous lesions but not in those whose tuberculosis was of the exudative type. It was found in many patients in whom it had not been clinically suspected.

That bronchography should be more commonly used in the study of tuberculous patients is quite apparent. Several possible reasons for the failure to use it were discussed. One of these is the belief that spread of the disease is a likely consequence. In this study the instillations of iodized oil were performed by moderately inexperienced persons, yet very few reactions occurred, and no spread was observed with certainty. The writer expressed the opinion that bronchography is relatively innocuous if the patient is premedicated with 1½ grains (0.09 Gm.) of pentobarbital sodium to help prevent a tetracaine reaction.

Reaction Following Bronchography.—Severe or fatal reactions occurring after intratracheobronchial instillations of iodized oil are relatively rare. In a review of the literature Mahon [37] found a number of reports, but with respect to many it was difficult to form any adequate opinion concerning the cause of death, and therefore one could not be certain that the reactions were due to iodized oil.

In the case reported by him the first symptom noted was a severe generalized convulsion. The patient was given 7½ grains (0.5 Gm.) of "amytal sodium" within one minute after the onset of the convulsion because the possibility of a cocaine reaction was considered. A few minutes later the patient became extremely cyanotic and stopped breathing. Artificial respiration was unsuccessfully carried out, and he was pronounced dead about ninety minutes after cocainization of the throat preliminary to instillation of iodized oil.

The final pathologic diagnosis, based on postmortem examination, was: bilateral complete tracheobronchial obstruction due to inspissated mucus; massive pulmonary collapse and death from asphyxia. In addition there were noted bronchiectasis and pulmonary fibrosis.

Three cases of bilateral pneumonia which developed subsequent to intrabronchial instillation of iodized oil were reported by Kooperstein and Bass.[38] Sensitivity tests seemed to indicate that the iodized oil was the agent responsible for the acute pulmonary episodes. The bilateral basal lesions which developed in the portions of the lung fields in which iodized oil was previously instilled and the associated hives and

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36. Boyer, L. B.: Bronchography in Tuberculosis, Am. Rev. Tuberc. **54**: 111 (Aug.) 1946.

37. Mahon, G. S.: Reaction Following Bronchography with Iodized Oil, J. A. M. A. **130**:194 (Jan. 26) 1946.

38. Kooperstein, S. I., and Bass, H. E.: Pulmonary Reaction Following Intrabronchial Instillation of Lipiodol in Bronchial Asthma, Am. J. Roentgenol. **56**: 569 (Nov.) 1946.

eosinophilia occurring in known cases of asthma suggested further investigation. It was of interest to note that in point of time elapsing between the instillation of the iodized oil and the development of pneumonia the latter resembled the delayed reaction of serum sickness.

Cooperation of Anesthesiologist and Bronchologist.—Both the bronchologist and the anesthesiologist are actively interested in the study of respiration. Each deals directly with disease of the respiratory tract or with disturbances of respiration.

In a discussion of this problem, Cassels and Holinger[39] presented an analysis of the interlocking phases of the two fields, anesthesiology and bronchoesophagology, and methods by which these might be integrated for mutual benefit. While both specialists are concerned with the general condition and welfare of the patient, their points of view are slightly different. The anesthesiologist has a great deal to contribute to the work of the bronchologist, and it is to be hoped that the bronchologist will increasingly recognize the importance of having the cooperation of the anesthesiologist in many cases in which his assistance is of value. In cases of toxic reactions to drugs used to induce local anesthesia, the presence of an anesthesiologist may be of extreme value.

The administration of an anesthetic is not merely a technical procedure. It involves great hazards for the patient and requires judgment as to the choice of agent and method, dosage, diagnosis of complications and institution of appropriate treatment. The patient's welfare and even his life are placed in jeopardy whenever an anesthetic is administered. It has been the policy of the members of the medical profession to restrict to themselves the prerogative of jeopardizing the patient's welfare in the hope that benefit may result. It seems deplorable that in the field of anesthesiology this prerogative has been delegated to lay technicians who are quite incapable of using the fine judgment required. For this reason, as well as for that of obtaining the benefit of a wide selection of procedures, bronchologists, as well as other surgeons, are benefited by the assistance of trained anesthesiologists.

A completely new method of obtaining local anesthesia for endoscopic procedures is reported by Remorino.[40] This consists in nebulization of a solution of tetracaine hydrochloride, which the patient inhales by mouth for fifteen minutes prior to the bronchoscopic or esophagoscopic procedure. This anesthetizes the pharynx, larynx and trachea satisfactorily. The quantity of anesthetic used is negligible, usually not more than 2 cc. The nebulizer is not unlike that commonly employed

39. Cassels, W. H., and Holinger, P. H.: Points of Mutual Interest in Bronchology and Anesthesiology, Ann. Otol., Rhin. & Laryng. **55**:638 (Sept.) 1946.

40. Remorino, A. G.: Anesthesia by Nebulization for Bronchoscopy, Rev. argent. bronco-esofagol. **2**:25 (July) 1946.

and is efficient. The patient is able to anesthetize himself, so that while the bronchologist is busy the next patient, without any assistance, is anesthetizing himself.

Reaction Following Anesthesia Induced with Tetracaine Hydrochloride ("Pontocaine Hydrochloride").—With the increasing employment of tetracaine hydrochloride it is to be expected that toxic reactions will occur. Tetracaine is considered to possess fifteen times the anesthetic power of cocaine but is two and a half times as toxic in the same concentration. The toxic properties of tetracaine are similar to those of cocaine and other drugs used to produce local anesthesia. A case of overdosage of this drug has been reported by Ahroon [41]:

> The patient, a 27 year old woman, was examined bronchoscopically without untoward effects following the employment of about 5 cc. of a 2 per cent solution of tetracaine hydrochloride. Ten days later she reported for bronchography, and after the pharynx had been sprayed with a 2 per cent solution of tetracaine hydrochloride and after 2 cc. of the solution had been instilled into the trachea and then an additional 2 cc. through the catheter into the bronchi, the patient complained of dizziness, and an excess of secretions appeared to accumulate in the trachea. She then had a generalized clonic convulsion of short duration, and after five similar convulsions she died in spite of intravenous administration of phenobarbital sodium, artificial respiration and other measures.
>
> It was subsequently found that the solution of tetracaine hydrochloride used was stronger than 2 per cent. The strength of the solution was about 6 per cent, and the explanation was that it was kept in a poorly stoppered bottle and had concentrated itself by evaporation.

TUBERCULOSIS

Tuberculous Tracheobronchial Lymphadenitis.—A tuberculous lymph node perforating into the tracheobronchial tree is probably more common than reports would indicate. Sayé and his associates [42] discussed this problem and presented a series of 7 cases. The ages of the patients varied from 9 to 27 years. In 6 of the cases the lesions occurred in the proximal and middle thirds of the main bronchi along the lateral wall.

The bronchoscopic appearances were those of an edematous and congested zone surrounding a small whitish lesion 2 to 3 mm. in diameter or a single ulcer 3 to 5 mm. wide with raised edges and draining caseous material. There may be a regressive type with irregular scarring and some calcification. Biopsy commonly reveals material suggesting a lymph node.

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41. Ahroon, W. A.: Report of a Death from Pontocain Hydrochloride, Laryngoscope **56**:320 (June) 1946.

42. Sayé, L.; Bence, A., and Fernandez Luna, D.: Tracheobronchial Perforation in Tuberculosis of Intrathoracic Lymphnodes, Rev. argent. de broncoesofagol. **2**:8 (July) 1946.

Many infections of childhood have been considered as causes of bronchiectasis. Recent data have shown a definite relationship between tuberculosis of the tracheobronchial tree, obstructive pneumonitis and atelectasis. Jones and her co-workers [43] reported a roentgenographic study of 716 children admitted to a hospital over a five year period in which 12 per cent of the roentgenograms showed segmental or lobar shadows suggesting obstructive pneumonitis. Forty-two of the patients were examined bronchoscopically, and in 31 there was found tuberculous involvement of a bronchus which appeared as endobronchial ulceration, granulation tissue or tuberculoma or as a compressive lesion caused by enlarged tuberculous lymph nodes.

A certain number of these patients were recalled several years later for study to determine whether bronchiectasis was present. A group of 37 were studied, and iodized oil was instilled. In 3 the oil could not be placed in the previously involved areas. Of the remaining 34, however, obvious signs of bronchiectasis were demonstrated in 24, or 70 per cent. Few of the 24 with bronchiectasis presented conspicuous symptoms. One was advised to submit to pneumonectomy.

From this study it is apparent that in children pulmonary tuberculosis is a common cause of bronchiectasis.

Cytologic Study of Bronchial Secretions in Tuberculosis.—In bronchial secretions studied for neoplastic cells Herbut and Clerf [44] observed small or large clusters of unusual epithelial cells in some cases. On the basis of further studies they concluded that a presumptive diagnosis of pulmonary tuberculosis could be made from a cytologic study of smears made of secretions bronchoscopically removed and stained by the Papanicolaou technic. Of importance in the diagnosis is the presence of roundish clusters of ciliated epithelial cells, single ballooned and vacuolated ciliated epithelial cells and giant cells of the Langhans type.

This method is of particular value in differentiating pulmonary tuberculosis from carcinoma in patients in whom the lesions are atypically situated, in whom there is little constitutional disturbance and in whom examination of sputum has failed to reveal tubercle bacilli.

PNEUMOTHORAX

Bronchoscopy was employed by Troise and del Valle [45] in 3 cases of spontaneous pneumothorax in an attempt to clarify the mechanism

43. Jones, E. M.; Peck, W. M., and Willis, H. S.: Bronchiectasis Following Primary Tuberculosis, Am. J. Dis. Child. **72**:296 (Sept.) 1946.

44. Herbut, P. A., and Clerf, L. H.: Cytology of Bronchial Secretion: A Diagnostic Aid, in the Diagnosis of Pulmonary Tuberculosis, Am. Rev. Tuberc. **54**:488 (Dec.) 1946.

45. Troise, C. A., and del Valle, F.: Bronchoscopy in Spontaneous Pneumothorax, Rev. argent. de broncho-esofagol. **2**:2 (July) 1946.

producing this condition. In all 3 cases it revealed bronchial obstruction due either to thick, viscid secretions or fibrinous material. Prompt recovery followed bronchoscopic removal. They concluded that bronchial obstruction may cause spontaneous pneumothorax by producing obstructive emphysema as demonstrated in their cases. Attention is directed to prompt bronchoscopic removal of the obstructing plugs.

FOREIGN BODIES IN THE AIR AND FOOD PASSAGES

Richardson [46] reviewed some of the salient clinical features of cases in which foreign bodies had lodged in various parts of the respiratory tract and emphasized certain pitfalls to be avoided in diagnosis and in treatment. The diagnosis of foreign body of the respiratory tract is easy if one remembers to think of the possibilities. The history of a foreign body accident should be accepted until proved wrong. Fluoroscopy of the chest is indicated when a nonradiopaque object is suspected; roentgen examination should include the entire respiratory and the gastrointestinal tract. Safe removal of a foreign body is facilitated by having a duplicate of the object for comparison and practice and by making an adequate roentgen study, so that the location and the position of the object are understood. It is important to have at hand an instrumentarium adequate to deal with any complications that might arise.

The average physician is interested in two phases of the problem of the foreign body lodged in an air or food passage, namely, how to make the diagnosis and then what to do with the patient once the diagnosis has been made. In discussing this, Ferguson [47] emphasized the symptoms of aspiration and those of ingestion of a foreign body and the importance of roentgen studies. It is necessary for physicians to educate patients to be more foreign body conscious. If parents were aware of this need they would exercise more care in selecting foods and toys for children. They should be trained always to close safety pins. This would aid materially in eliminating a certain number of cases of foreign body, and many children would be saved unnecessary illness and at times death.

Fluoroscopic Removal of Bronchial Foreign Bodies.—Objects located beyond the range of bronchoscopic vision should be removed only with the assistance of a biplane fluoroscope. Bence and Lanari [48] discussed

46. Richardson, J. R.: Foreign Bodies in the Respiratory Tract, New England J. Med. **235**:707 (Nov. 14) 1946.

47. Ferguson, G. B.: Diagnosis and Early Management of Inhaled and Ingested Foreign Bodies, North Carolina M. J. **7**:598 (Nov.) 1946.

48. Bence, A., and Lanari, C.: Foreign Body in a Bronchus at the Costophrenic Location Removed with Help of Improvised Fluoroscope, Rev. argent. de broncoesofagol. **2**:82 (July) 1946.

the difficulty of dealing with such objects and reported their experience in removing a metal clip from the right bronchus in the costophrenic region. They used a makeshift fluoroscopic apparatus, which consisted of a portable and a regular apparatus combined. The bronchoscope was introduced and examination was made in the vertical plane with the regular apparatus, while the portable apparatus was used in the lateral plane. With this arrangement the foreign body was grasped and successfully removed.

Two cases of foreign body of the bronchus, a common pin in one and a dental burr in the other, were reported by Abalo.[49] In each instance the object was lodged in a subdivision of a lower lobe bronchus beyond bronchoscopic vision. Being without the aid of a double plane fluoroscope and too far from access to one, the author decided to try a single plane fluoroscope. In each instance the patient was placed in the lateral position and then rotated to the anteroposterior position; this was repeated a number of times until the forceps were approximated as close to the foreign body as possible, the blades were opened, the foreign body grasped and removed. The author very properly emphasizes that this should not be practiced routinely, as it is dangerous because of the possible traumatization of the bronchial wall.

Bernstein[50] removed a doughy mass, a tortilla, from the cervical portion of the esophagus of a man. Since the dough could not be grasped with forceps, an esophagoscope was passed into the mass, which adhered to its walls and also entered its lumen. With removal of the esophagoscope the mass also was removed and was found to measure 15 by 8 mm. The patient made a prompt and satisfactory recovery and suffered no ill effects from his experience.

Two cases in which the aorta was perforated by swallowed bones are reported by Haines.[51] In each instance esophagoscopy was performed several days after the accident. In neither could a foreign body be located. The lodging of a foreign body at the level of the aorta adds additional hazards because of the pressure exerted by the pulsating vessel, and this probably was a factor in the first case. The report emphasizes that the esophagus should be submitted to prompt direct examination when there is a history of swallowing of a foreign body with persistence of symptoms, even in the presence of a negative roentgenographic report.

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49. Abalo, M. A.: The Extraction of Bronchial Foreign Bodies Situated Outside the Zone Accessible to the Bronchoscope, Arch. Soc. estud. clin. Habana **50**:3 (March-April) 1946.

50. Bernstein, D.: Removal of a Tortilla from the Esophagus, Arch. Otolaryng. **43**:629 (June) 1946.

51. Haines, M.: Perforation of the Aorta by Swallowed Bones, Lancet **2**: 455 (Sept. 28) 1946.

While a pointed foreign body in the gastrointestinal tract is a potential hazard for perforation of the bowel, Best [52] expressed the opinion that surgeons who have had great experience in the management of such cases would advocate careful observation and nonsurgical treatment, while those with only an isolated experience would favor surgical removal.

If a sharp-pointed object remains stationary for twenty-four hours after leaving the stomach, careful observation of the patient is indicated and if it remains immobile beyond forty-eight hours, surgical intervention should be seriously considered. Penetration or perforation of the bowel should be suspected in the presence of changes of pulse rate, temperature and blood count and abdominal tenderness and muscular rigidity. The usual treatment is watchful waiting with careful repeated roentgenographic observation. There is no advantage in changing the diet.

ESOPHAGOSCOPY

Congenital Anomalies of the Esophagus.—Resano and Arauz [53] discussed various esophageal abnormalities, including stenosis due to ulceration and peptic ulcers, cicatricial stenosis, neoplastic stenosis and malformations, together with the acute and chronic complications. The value of roentgenography esophagoscopy and biopsy was presented.

A case of dysphagia resulting from gastric disease occurring in a man who had a congenitally short esophagus was presented. Roentgen study revealed no esophageal obstruction but showed gastric stenosis due to a cicatricial contraction probably of an ulcer of the fundus of the stomach.

In congenital short esophagus the most prominent symptom is dysphagia. In every case in which roentgen examination showed narrowing of the esophagus with smooth borders between the tracheal bifurcation and the diaphragm one should suspect the presence of a congenital short esophagus. Esophagoscopy should confirm the diagnosis of congenital short esophagus, and biopsy should demonstrate the presence of gastric mucosa several centimeters above the diaphragm, Observations based on roentgenologic studies of patients should be looked on with suspicion when not accompanied by the results of endoscopic examination and biopsy.

Holt and his associates [54] discussed the various roentgenologic methods of examining congenital atresia of the esophagus, a condition

52. Best, R. R.: Management of Sharp-Pointed Foreign Bodies in the Gastrointestinal Tract, Am. J. Surg. **72**:545 (Oct.) 1946.

53. Resano, H., and Arauz, C.: Endoscopic Considerations of the Congenitally Short Esophagus, Rev. argent. de bronco-esofagol. **2**:28 (July) 1946.

54. Holt, J. F.; Haight, C., and Hodges, F. J.: Congenital Atresia of Esophagus and Tracheoesophageal Fistula, Radiology **47**:457 (Nov.) 1946.

which now has become amenable to surgical treatment. Experiences derived from examination of 45 consecutive patients with this anomaly, 42 of whom had associated tracheoesophageal fistula, are discussed. The findings in an additional patient with congenital tracheoesophageal fistula but with no esophageal atresia are recorded.

Consideration is given to the roentgenologic measures that are valuable for the establishment of the diagnosis of the anomalies and for evaluation of any complicating pulmonary lesion which may be present. The importance of roentgenologic examination and the methods of using this procedure in postoperative management are stressed.

Surgical exploration was undertaken in 36 patients of this group, and intrathoracic reconstruction of the esophageal continuity was an accomplishment in 26. The roentgenologic features of 9 living patients who have survived operations for periods of from six months to three and three-fourths years are presented.

Acquired Esophagotracheal Fistula.—An unusual case of esophagotracheal fistula due to a crushing injury without any demonstrable fracture of ribs, sternum or cartilages was reported by Adams and Mabley [55]:

> The patient, a youth aged 19 years, was struck on the chest by a box weighing 700 pounds (317.5 Kg.) which had fallen from a height of 10 feet (3 meters). It was necessary to do tracheotomy immediately because of marked emphysema of the neck and face. Attempts to swallow fluids or even saliva produced severe and prolonged paroxysms of coughing and regurgitation through the tracheotomy wound. A Levine tube was inserted, and later gastrostomy was done.
>
> With improvement in the patient's condition, esophagoscopic and bronchoscopic examinations were carried out. These revealed a large esophagotracheal fistula above the level of the carina. It was soon realized that spontaneous healing would not take place and that the patient was slowly losing ground because of severe paroxysms of coughing, which caused loss of rest. A transthoracic excision of the fistula was performed through the right side of the thorax. Infection was completely controlled by using penicillin constantly throughout the posttraumatic and operative periods, and a complete and satisfactory cure was obtained.

Acquired esophagobronchial fistula is uncommon, gives a poor prognosis and has a high mortality rate. Claggett and his associates [56] discussed the causes and reported the case of a patient who was successfully treated by surgical exploration and closure of the fistula:

> Three years prior to hospitalization there was a history of aspiration of a piece of meat, which was removed bronchoscopically six weeks later. Cough continued, and on one occasion some pieces of calcified material were expectorated. Later progressive dysphagia developed, and severe paroxysms of coughing occurred on taking liquids. There was progressive loss of weight. Esophagoscopic examina-

55. Adams, H. D., and Mabley, R. E.: Esophagotracheal Fistula Due to Nonpenetrating Crushing Injury, J. Thoracic Surg. **15**:290 (Aug.) 1946.

56. Claggett, O. T.; Payne, J. H., and Moersch, H. J.: Acquired Esophagobronchial Fistula, Surg., Gynec. & Obst. **82**:87 (Jan.) 1946.

tion prior to operation disclosed a sinus opening on the right lateral wall of the esophagus in its middle third. Bronchoscopy revealed a fistulous opening on the posterior wall of the right main bronchus through which esophageal secretion was coming.

After surgical closure of the fistula, the patient made a very satisfactory recovery and remained free from symptoms. Pathologic studies of the tissue removed at operation revealed chronic inflammation and tuberculosis.

Perforation of the Esophagus.—In 6 of 8 consecutive cases of perforation of the esophagus reported by Engler [57] the cause was foreign body; of the remaining 2 cases the cause in one was cauterizing lye ingested with suicidal intent and in the other syphilis. Of the 6 patients with esophageal perforation caused by foreign body, 2 were treated conservatively and experienced spontaneous recoveries. The other 4 were subjected to mediastinotomy, with recovery in 3 and death in 1 from a fulminating periesophageal infection that developed after removal of the foreign body, a denture. The patient whose bronchoesophageal fistula resulted from ingestion of lye died after being discharged from the hospital, by suicide, and the other, from the disease.

In all the cases roentgenographic examination and endoscopy were important in establishing the diagnosis. In 2 of the cases of esophageal perforation caused by foreign bodies the foreign bodies were not visualized roentgenologically, nor esophagoscopically, and were not removed.

Two cases of mediastinitis with esophageal perforation were reported by Grez [58]:

In the first, a case of cicatricial stenosis of the esophagus due to accidental ingestion of nitric acid, dilation was instituted, beginning with bougie no. 12 and rapidly increasing to no. 18. The patient then discontinued treatment but returned in nine months with dysphagia and ability to swallow only a small amount of liquid. Esophageal dilations were resumed, and then pains developed in the neck and the left side of the chest. Gastrostomy was done. A roentgen study revealed widening of the superior mediastinum, especially left sided, extending to the cervical region. This was interpreted as a mediastinal abscess, and 20,000 units of penicillin was given intramuscularly every three hours. In forty-eight hours the temperature returned to normal and pain disappeared. A total of 1,000,000 units of penicillin was given in five days. Roentgen studies showed complete disappearance of mediastinal shadows.

In the second case a woman of 33 years had gastric pain and dysphagia of four years' duration. Esophagoscopy revealed swollen esophageal mucosa and stenosis at the hiatal level. Following attempts at esophageal dilation, severe thoracic pain developed, radiating to the back. A roentgenogram showed widened

57. Engler, C. W.: Perforation of the Esophagus Not Caused by Instrumentation: Report of Eight Cases, Ann. Otol., Rhin. & Laryng. **55**:667 (Sept.) 1946.

58. Grez, A.: Two Cases of Mediastinitis with Esophageal Perforation Treated with Penicillin Followed by Cure, Rev. argent. de bronco-esofagol. **2**:71 (July) 1946.

mediastinal shadows, and a diagnosis of mediastinitis due to perforation of the esophagus was made. Gastrostomy was done and penicillin administered. Recovery resulted, and the stenosis was treated by retrograde bougienage.

Knight [59] reported his experiences with various types of combat-incurred injuries involving the neck and the thorax. Several cases and the plans of treatment required are reported in detail. In one of these stenosis of the trachea, necessitating tracheotomy and later laryngostomy, developed over four months after the patient was injured in an explosion. He was exposed to carbon tetrachloride and possibly also to sulfur fumes. A hollowed acrylic obturator was employed and remained in the trachea for three months following the laryngostomy.

Dysphagia.—In a discussion of the causes of dysphagia, Johnston [60] found it difficult to understand why knowledge of esophageal disease has been so backward, particularly when one recalls that the esophagus can be readily examined by direct means and its function studied by means of roentgenograms. While this article is presented largely from a roentgenologic standpoint, the subject has been thoroughly discussed and is well illustrated.

Peptic Ulcer.—Peptic ulcer of the esophagus, long considered a rarity, was believed to be found mainly where there was a congenitally short esophagus. During the past five years, at the General Infirmary at Leeds, England, Allison [61] observed 37 patients with lesions proved to be peptic ulcers and 6 with esophagitis associated in all instances with diaphragmatic and gastroesophageal inefficiency. In his opinion the cases cannot be divided into two categories, for esophagitis is merely a stage in the development of the peptic ulcer.

Where the lower end of the esophagus is frequently digested by acid gastric juice, peptic ulcer of the esophagus will occur. This happens when inefficiency of the diaphragm allows the stomach and the abdominal portion of the esophagus to slide up into the mediastinum. Such herniation may be congenital or acquired. When medical measures fail to relieve symptoms, the problem becomes a surgical one, with replacement of the stomach in the abdomen and restoration of the length of the esophagus. The size of the hiatus may be diminished in order that the organs may be maintained in their normal positions. With chronic ulceration and fibrosis leading to inelasticity of the esophagus, anatomic restoration may not be possible.

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59. Knight, J. S.: Injuries to the Trachea and Esophagus Occurring in Combat, Ann. Otol., Rhin. & Laryng. **55**:656 (Sept.) 1946.

60. Johnston, E. A. S.: Dysphagia Due to Causes Other Than Malignant Disease, Edinburgh M. J. **53**:160 (April) 1946.

61. Allison, P. R.: Peptic Ulcer of the Esophagus, J. Thoracic Surg. **15**: 308 (Oct.) 1946.

Injection Treatment of Esophageal Varices.—In their experience with 12 patients with esophageal varices, Patterson and Rouse [62] found that obliteration of the veins results in no appreciable unfavorable effects but rather in a clinical improvement that occurs soon after prevention of the loss of blood due to rupture of varices. The youngest patient treated was 3 years and the oldest 66 years of age. Injections were made into one or more veins, sodium morrhuate injection U. S. P. being used. Patients received at most three or four injections at intervals varying from one week to one year. In 1 patient injections were done before and also after splenectomy; in 4 patients injections were performed after splenectomy, and in 7 of older age splenectomy had not been done. While the ultimate therapeutic evaluation of the injection of a sclerosing solution will have to await time and the careful observation of patients, the results thus far observed tend to justify the procedure.

Angioma of the Esophagus.—Blanco and his associates [63] reviewed an extensive literature on this subject and reported the case of a man 45 years of age, admitted to the hospital because of hematemesis and melena. The patient's hemoglobin was only 50 per cent of normal on admission. The clinical history and the roentgen findings were negative for ulcer. Esophagoscopic examination revealed the esophageal mucosa to be the seat of numerous telangiectatic areas with punctiform angioma, none of which seemed to be bleeding at the time of examination. There were similar lesions on the inferior and lateral surfaces of the tongue and on the surface of the scrotum. Examination of the blood gave negative results.

The lesions appeared to represent angiokeratoma as described by Fordyce-Sutton. The presence of angiokeratoma on the inferior surface of the tongue is not an unusual finding, as this has been observed in many previous cases of angiokeratoma of the scrotum. Finding similar lesions in the esophagus is a rarity, according to the literature, and in the opinion of the authors its rarity is probably due to the fact that the esophagus is not investigated in these cases, as often the patients have no symptoms referable to the esophagus. They admitted that they would have overlooked this had it not been that they were trying to find the cause of hematemesis, which was suspected of being of esophageal origin.

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62. Patterson, C. O., and Rouse, M. O.: The Injection Treatment of Esophageal Varices, J. A. M. A. **130**:384 (Feb. 16) 1946.

63. Blanco, F. L.; Abalo, M. A., and DeLaosa, O.: A Case of Angiokeratoma of the Scrotum of the Fordyce-Sutton Type with Multiple Angioma of the Inferior Surface of the Tongue and Esophageal Mucosa, Complicated with Hematemesis and Melena, Bol. Soc. cubana de dermat., sif. **3**: 59 (June) 1946.

Scleroma.—Scleroderma is generally recognized as the cutaneous manifestation of a disease which affects several systems of the human organism. In the 2 cases reported by Rafsky and Herzig [64] the skeletal, vascular and gastrointestinal symptoms showed typical alterations aside from the cutaneous changes. In 1 patient, a woman aged 73 years, there was progressive dysphagia with loss of weight. A roentgen study of the esophagus revealed appearances suggesting achalasia. At esophagoscopy dilatation of the esophagus and atrophy of the mucous membrane were observed. A biopsy revealed only normal squamous epithelium. The other patient, a man aged 32 years, complained of intermittent dysphagia. A roentgen study of the esophagus revealed spasm in the lower third with definite hesitation of barium sulfate at the cardia.

GASTROSCOPY

In an attempt to correlate the roentgen and gastroscopic findings with the known pathologic diagnosis of disease of the stomach, Benedict [65] studied 245 cases proved to be instances of carcinoma, gastric, duodenal and jejeunal ulcer, gastritis, benign tumor, lymphoma, sarcoma, metastic carcinoma of the gastric wall and normal stomach.

Although it probably is unfair to compare roentgen with gastroscopic findings, since the latter supplement the former and are in no way competitive, it can be stated that in certain instances the roentgen examination appeared to be superior to gastroscopy, and in other cases gastroscopy appeared to be superior to roentgen examination. The roentgen and gastroscopic examinations were about equally effective in 54 per cent of the cases; the roentgen examination was considered superior in 29 per cent and gastroscopy in 17 per cent.

The chief causes of gastroscopic failure are mechanical. If they could be eliminated, the percentage of cases in which roentgen examination appears superior to gastroscopy would be reduced to 6, compared with 17 in which gastroscopy seemed more accurate. From his analysis it appears that if the gastroscopist can secure a satisfactory view of the lesion his chances of reaching a correct diagnosis are greater than those of the roentgenologist. Gastroscopists therefore should strive to bring about improvement in the gastroscope so that blind areas may be eliminated and biopsy specimens easily taken. Greater diagnostic accuracy is attained when both methods are used cooperatively, and from the patient's standpoint this is important.

64. Rafsky, H. A., and Herzig, W.: Scleroderma with Esophageal Symptoms, Gastroenterology **6**:35 (Jan.) 1946.

65. Benedict, E. B.: Correlation of Gastroscopic, Roentgenologic and Pathological Findings in Diseases of the Stomach, Am. J. Roentgenol. **55**:251 (March) 1946.

Biopsy.—A frequent error encountered by the surgeon and the internist is that of the differentiation of early gastric carcinoma and benign ulcer. A biopsy specimen obtained with special forceps attached to the gastroscope provides positive evidence of the pathologic process. Kenamore and his co-workers [66] obtained 35 biopsy specimens without untoward reaction; in some instances they were unable to obtain tissue for biopsy by reason of a blind spot or inability to reach the involved area. The biopsy gastroscope was used only after a preliminary visual examination had been made with the examining gastroscope.

Four cases are presented with this report, in which the biopsy diagnoses were (1) adenocarcinoma, (2) lymphosarcoma, (3) hypertrophic gastritis and (4) chronic atrophic gastritis. This instrument permits a more exact study of gastric lesions and is safe in trained hands.

Premedication for Gastroscopy.—For successful gastroscopic examination it is important that the patient should be cooperative and mentally and physically relaxed. The type of sedative and anesthetic depend on the state of the patient. The patients examined by Monat [67] in the military service were between 20 and 30 years of age. This is a younger age range than that of patients encountered in civilian life, who are usually between 40 and 60 years of age.

It was found that "pantopon" (a mixture of hydrochlorides of opium alkaloids) gave the best results of all the drugs used, especially in the younger patients. Morphine was next best, although occasionally it produced a violent reaction. Meperidine hydrochloride ("demerol hydrochloride") with or without atropine proved most disappointing. As a result "pantopon" was preferred for younger patients and pentobarbital sodium ("nembutal") for older or less tense patients.

For local anesthesia, a 2 per cent solution of cocaine hydrochloride was applied to the posterior pharyngeal wall three times at three minute intervals and then to both piriform sinuses for about ten minutes; then 2 cc. of a 2 per cent solution of tetracaine hydrochloride was injected into the hypopharynx with a laryngeal anesthetizing tube. After a period of five minutes the patient was ready for gastroscopic examination.

Fluorescein as an Aid.—Fluorescein has been used to outline ulcers of the cornea. This suggested to Robinson [68] that it might be used in the detection of erosions or ulcerations of mucous membrane surfaces. He used fluorescein topically by instilling 10 cc. of a 1 per cent solution

66. Kenamore, B.; Scheff, H., and Womack, N.: Study of Gastric Lesions by Means of Biopsy Specimens removed Endoscopically, Arch. Surg. **52**:50 (Jan.) 1946.

67. Monat, H. A.: Observations on Premedication with Various Drugs in Three Thousand Gastroscopies, Rev. Gastroenterol. **13**:440 (Nov.-Dec.) 1946.

68. Robinson, H. M.: Fluorescein: An Aid in Gastroscopy, Rev. Gastroenterol. **13**:303 (July-Aug.) 1946.

of fluorescein sodium through an Ewald tube into the stomach after the gastric contents had been drained. Then gastroscopy was done. In a series of 22 cases there were 4 cases of superficial ulceration of the stomach. The dye aided in outlining and demonstrating the ulcer and also made it possible to estimate the diameter of the lesion more accurately.

Gastroscopic Perforation of the Esophagus.—Complications following introduction of the flexible gastroscope have been rare. In the case reported by Paul and Antes,[69] considerable manipulation was necessary in order to pass the tube into the esophagus, and this undoubtedly was a factor in the perforation.

This accident occurred during the "1,711th gastroscopic examination" and resulted in a retropharyngeal abscess. The complication was promptly recognized, and forty-eight hours after the gastroscopic mishap a retropharyngeal abscess was drained through a lateral incision of the left side of the neck. No perforation of the esophagus was found. The patient ultimately recovered, although the postoperative course was fairly stormy.

69. Paul, W. D., and Antes, E. H.: Perforation of the Esophagus Caused by Flexible Gastroscope, Rev. Gastroenterol. **13**:23 (Jan.-Feb.) 1946.

Abstracts from Current Literature

Ear

THE USE OF STREPTOMYCIN IN THE TREATMENT OF DIFFUSE EXTERNAL OTITIS. BEN H. SENTURIA and R. H. BROH-KAHN, Ann. Otol., Rhin. & Laryng. **56**:81 (March) 1947.

There have been many reports of the occurrence of Pseudomonas (gram-negative motile rods, growing on ordinary nutrient mediums and producing a characteristic water-soluble, chloroform-soluble greenish pigment). The authors feel that this organism may be the causative agent of diffuse external otitis: It was found in a high percentage of the cases; it was not isolated from normal canals; successful treatment resulted in rapid disappearance of the organism; persistence of the organism was found in cases in which treatment failed to cure, and was observed prior to imminent relapse subsequent to cessation of therapy. Treatment was carried on with 250 micrograms, 1 mg. and 5 mg. of streptomycin per gram of "carboprop" ointment base (60 parts of "carbowax 4000" and 40 parts of propylene glycol). "Carboprop" was used alone in a group of controls. The weaker streptomycin ointments were no more effective than the ointment base alone, but the ointment containing 5 mg. of streptomycin per gram of base gave promising and beneficial results. One patient was given 100 mg. of streptomycin parenterally every three hours for three days for a total of 2.4 Gm. There was little improvement in this patient's condition.

M. V. MILLER, Philadelphia.

CRITICAL SURVEY OF THE LEMPERT ENDAURAL FENESTRATION OPERATION. MARVIN F. JONES, Laryngoscope **57**:263 (April) 1947.

Jones surveys the Lempert fenestration in all its aspects. The discussion of these various phases is most interesting and helpful. Any one contemplating fenestration surgery should be mindful of all Jones emphasizes, particularly that pertaining to the necessity of possessing particular surgical ability and thorough training.

HITSCHLER, Philadelphia.

DR. PROSPER MÉNIÈRE: A HISTORICAL SKETCH. WALTER A. WELLS, Laryngoscope **57**:275 (April) 1947.

It was Prosper Ménière, rather than Emile Antonine Ménière, his son, who first commented on the condition now commonly referred to as Ménière's disease or syndrome. His son, an otologist, has frequently been given the credit for the discovery.

To quote Prosper Ménière's report of his well known case, the semicircular canals were filled with a "reddish plastic exudate." Later, this statement was misquoted, to the effect that there was a labyrinthine hemorrhage. It was the misquoting that largely discredited Ménière's diagnosis. His original description can hardly be improved on today.

Wells mentions other interesting facts concerning the discovery and history of the syndrome.

A bibliographic sketch of Prosper Ménière is given.

HITSCHLER, Philadelphia.

THE FENESTRATION OPERATION: AN EVALUATION OF ITS PRESENT STATUS. G. E. SHAMBAUGH JR., Surg., Gynec. & Obst. **84**:828 (Feb.) 1947.

Shambaugh proposes to classify cases for surgical fenestration of the labyrinth as follows:

"Class A. Ideal: Normal hearing by bone for speech frequnecies. Prognosis: 8 in 10 chances of permanent hearing improvement within the 30 decibel practical level.

"Class B. Suitable, but not ideal: Normal hearing by bone except for one of the speech frequencies that shows a loss of 30 decibels or more. Prognosis: 50-50 chance of sufficient gain to do without a hearing aid.

"Class C. Experimental: Two or more of the speech frequencies show a 30 decibel or greater loss by bone but the Rinne test for the 1024 fork is negative. Prognosis: A remote 1 in 10 chance of sufficient improvement to give practical hearing without an aid.

"Class D. Unsuitable due to incomplete stapes fixation or to profound nerve degeneration. Operation contraindicated."

He urges that the poorer hearing ear be chosen for this operation to minimize any risk to the patient's better hearing ear. Audiometric measurements on bone conduction should be performed with adequate masking of the opposite ear. In addition, testing with certain tuning forks is of value. Among these are 64, 512, 1024 and 2048 forks. Inability to hear the 64 fork indicates complete fixation of the stapes; ability to hear the fork at moderate intensity signifies only partial fixation of the stapes, and here surgical intervention offers too little to be worth while. A Rinne test with the 1024 fork which gives a negative result offers a favorable operative result even though the patient may fall into class B or C. A Rinne test with the 512 fork which gives a positive result usually implies only partial fixation of the stapes and is a contraindication to surgical treatment. If the 2048 fork is not heard by bone (with masking), the prognosis is extremely poor.

Various modifications of the technic of surgical fenestration of the labyrinth have been proposed. Final decision as to which technic is the most reliable will probably await a comparative statistical analysis of the different methods. From the point of view of the patients: 82 per cent of those operated on by the author and his associates regard the procedure as successful and do not use a hearing aid.

An interesting question is raised concerning the possible arresting effect of successful fenestration on eighth nerve degeneration. Further evidence will be needed for evaluation of this possibility. The risks of the operation are minimal, being chiefly to the facial nerve and the labyrinth. There is a tendency at present to regard the hearing results found two years after operation as permanent.

FRIEDBERG, Chicago.

CONSIDERATION OF HEARING IMPAIRMENT IN THE TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA. J. H. MAXWELL, Surg., Gynec. & Obst. **84**: 845 (April) 1947.

Attention is directed to the fact that the preservation of residual hearing or the improvement of hearing is not the major concern in dealing with chronic suppuration of the middle ear. The otologist must be mindful of the extent and dangers of the infection and, having dealt adequately with this factor, pursue a course which will tend to preserve all residual hearing or even improve the

auditory acuity. Individualization of each case is required, and routine methods of therapeutics in dealing with chronic disease of the middle ear are to be discouraged. A thorough history and a detailed examination are prerequisite; signs and symptoms of extension of the infection must be watched for, and the significance of various types of tympanic perforations and secretions should be well understood.

The anterior inferior or "tubal" perforations require treatment directed to the nose and the nasopharynx, and antiseptic solutions should be applied locally to the tympanum. Large marginal perforations with granulations of the promontory but without cholesteatoma may be treated conservatively. A hearing loss of around 30 to 40 decibels usually accompanies this type of lesion.

Attic involvement or posterosuperior marginal perforations with odorous secretion usually imply serious potentialities. A hearing loss of 50 to 60 decibels may be present. Radical mastoidectomy is frequently indicated, and one should expect complete healing in over 95 per cent of adult patients. Hearing will not be restored but may be improved or may be lost entirely in the ear operated on. Procrastination may lead to intracranial complications, and the author stresses the fact that indications for radical mastoidectomy are present and must be discovered before a complication occurs.

The primary form of acquired cholesteatoma with attic perforation is often characterized by reasonably good hearing and may occasionally be treated successfully by irrigations of the attic. If operation is required, the attic mastoidectomy described by Lempert is the procedure of choice. Preservation of the pars tensa assures the maintenance of tympanic air space about a stapes which has not been disturbed and offers an excellent prospect of obtaining a dry ear with preservation of serviceable hearing. This of course is preferable to the classic radical mastoidectomy with its proportionately greater loss of hearing.

FRIEDBERG, Chicago.

Pharynx

IRRADIATION OF THE NASOPHARYNX. SAMUEL J. CROWE, Ann. Otol., Rhin. & Laryng. **55**:779 (Dec.) 1946.

Crowe discusses the genesis of his radiation treatment of the lymphoid tissue of the nasopharynx. He points out the fact that the lymphoid tissue of the nasopharynx is an integral part of the mucous membrane and that in some children it will hypertrophy as a result of infection, allergy and other causes which are not understood. It was found that over 75 per cent of children who underwent adenoidectomy before puberty had recurrence and that nearly 40 per cent of these had either impaired hearing for high tones alone or for all tones of the speech range. The postoperative regrowth of this adenoid tissue predisposes to recurrent infections of the upper respiratory tract, attacks of suppurative otitis media, sinusitis and bronchial infections. In view of this he and his associates have, for several years, supplemented tonsillectomy with irradiation of the nasopharynx. The first treatment is given two weeks after operation, and two more are given at two week intervals. Operative removal of large adenoids followed by a series of radium treatments is always more satisfactory than irradiation alone.

Often there is compensatory hypertrophy of lymphoid nodules in the pharynx and nasopharynx after removal of the tonsils and adenoids. Even though these may be small in size, they may be so placed that they interfere with the function of the eustachian tubes. Radiation is of great value in restoring patency of these

tubes. Nodules of hyperplastic and infected lymphoid tissue occurring in the nose near the posterior end of the middle turbinate may cause symptoms resembling those of vasomotor rhinitis. Crowe believes that lymphoid tissue in this position is a common cause of ethmoiditis and sphenoiditis in children. Lymphoid nodules in the nose and about the eustachian tube are often so small that they can be seen only with the nasopharyngoscope. They should be looked for, and if present, removed by irradiation rather than by surgical excision or cauterization. Edema is a constant factor following irradiation; so it is advisable to omit treatments during acute infection of the respiratory tract, and in the presence of subacute or chronic infections, to allow a three or four week interval between treatments.

The technic of anesthetizing childrens' noses for the examination is described, and the placing of the applicator and the dosage of the radiation are well covered.

M. V. Miller, Philadelphia.

A Method of Minimizing Contracture Following Cleft Palate Operations. H. Baxter and M. Cardoso, Plastic & Reconstr. Surg. **2**:214 (May) 1947.

The authors present a modification of methods already in use for the correction of cleft palate. A dental compound stent is molded to fit the space concerned, and around this a split skin graft from a hairless area of the body is wrapped with the raw surface outward. The use of the stent keeps the skin graft in close contact everywhere with the mucoperiosteal flap and with the bony palate. This favors a complete union of the tissues and also prevents premature contraction of the skin graft. Two or three weeks later the usual push-back operation is performed.

After the second operative stage it is particularly important that the skin graft be trimmed away from the edges of the palatal flap, to allow enough raw surface to unite with the adjacent part of the palatal bone. Wire or dermal sutures are used to prevent the tip of the flap from moving forward. The cleft is then closed in the usual way. Four to six weeks after the operation is completed, the authors favor palatal massage to increase mobility. Results have been uniformly satisfactory, including those following speech training.

Seltzer, Philadelphia.

Larynx

Laryngeal Edema, Myocarditis and Unexpected Death (Early Acute Laryngotracheobronchitis). Otto Saphir, Am. J. M. Sc. **210**:296 (Sept.) 1945.

The author reports 5 cases of rapidly developed symptoms of obstruction of the upper respiratory tract; the patients succumbed quickly despite tracheotomy. Autopsies disclosed severe laryngeal edema, edema of the epiglottis and subglottic area and acute myocarditis. The edema is interpreted as an early stage of so-called laryngotracheobronchitis. The unexpected death was probably caused by myocarditis. If in future instances the attending physician is aware of this complication, supportive measures might forestall the fatal outcome.

Henske, Omaha. [Am. J. Dis. Child.]

A Review of Tuberculosis in the Field of Otolaryngology for the Past Year. Frank R. Spencer, Laryngoscope **57**:97 (Feb.) 1947.

The problem of relieving pain in the tuberculous larynx has been discussed by several authors. Bueno obtained good results by parenteral administration of a solution called the compound A of Gillot (a 1 per cent solution of a purified oil or resin). LeLourd favors infiltrating procaine hydrochloride into the carotid

sinus, while Myerson had good results using a sulfonamide compound in a spray.

Auerbach presented figures resulting from gross and microscopic studies of lesions at autopsies.

Several authors discussed various therapies. Streptomycin, used both locally and parenterally, shows much promise. Spencer feels that this drug is one of the most outstanding contributed to the treatment of tuberculosis in many years.

HITSCHLER, Philadelphia.

CARCINOMA OF THE LARYNX; ITS DIAGNOSIS AND TREATMENT. CLAUD C. CODY JR., Texas State J. Med. **42**:495 (Dec.) 1946.

The author stresses the importance of early accurate diagnosis of laryngeal cancer and states that such diagnosis combined with appropriate treatment converts a previously incurable condition with a mortality rate of 100 per cent into one the mortality rate of which is approximately 15 per cent. Hoarseness is given as the earliest and most persistent symptom of carcinoma of the vocal cords, but headache is mentioned as the most common of all symptoms. The presenting symptom is dependent on the location of the lesion. In intrinsic cancer the early presenting symptom is hoarseness. In extrinsic cancer of the larynx the presenting symptoms are all late; fortunately, this type of cancer is rare. The locations in order of frequency are: the vocal cords, the piriform sinus, the subglottis, the epiglottis, and the space anterior to the epiglottis. Carcinoma may be suspected by its appearance and location, but a definite diagnosis is made from a specimen taken, after induction of local anesthesia, by direct laryngoscopy and use of a punch forceps. Pachyderma, tuberculosis and syphilis must be considered in making a differential diagnosis of the lesion.

Broders' classification is of value in the selection of the treatment of choice.

In children papilloma of the larynx is dangerous only when it reaches sufficient size to obstruct breathing, but in adults, young or old, papilloma of the larynx is always potentially serious; frequently it is malignant. In the treatment of laryngeal cancer the method of choice is dependent on many factors. The duration of the disease, the location, the size and the degree of malignancy of the tumor, the age and the general health of the patient are all factors to be considered. Carcinoma grade 4 should be irradiated in accordance with the Coutard technic, while surgical removal is indicated for grades 1, 2 and 3. Local anesthesia induced with pentothal sodium is the anesthesia of choice for laryngeal surgery.

SINGLETON, Dallas, Texas.

Nose

ANTIBIOTICS IN THE TREATMENT OF SINUS INFECTIONS. HARRY P. SCHENCK, Ann. Otol., Rhin. & Laryng. **56**:38 (March) 1947.

The majority of acute sinus infections were adequately managed before the introduction of chemotherapy. The main advantage of antibiotic substances and sulfonamide compounds lies in their ability to control infections resistant to the ordinary rhinologic procedures, so that surgical intervention is either avoided or limited to simpler procedures. Penicillin, streptomycin and tyrothricin are the only antibiotics which have been found important, and each has a special sphere of use. They do not entirely replace the sulfonamide compounds, and frequently the two groups are beneficial when used together. Antibiotics are of little or no value in uncomplicated allergy but are useful in treating secondary infections. They

should not be used to prevent secondary infections, nor should they be used in mild and transient infections, as patients may become allergic to the antibiotics themselves, and it has long been recognized that immunity often is not acquired when an infection is promptly controlled by chemotherapy.

The rule that as little surgical intervention as possible should be employed in acute sinus infections is more definite since the introduction of chemotherapy, often even though orbital extension, bacteremia and retrograde thrombosis have occurred. Timely chemotherapy has almost eliminated these complications, and when they occur they may usually be readily controlled by chemotherapy. With or without chemotherapy, most sinus infections should be allowed to become chronic before resorting to surgery. Once collections of pus have developed, however, drainage must be established in spite of continuous chemotherapy.

Antibiotic therapy is not a cure-all, as it is effective only when directed against sensitive organisms, and, whenever possible, the vulnerability of the organism should be determined by sensitivity tests before treatment is started.

Chronic sinusitis is, in the main, resistant to antibiotics, as the drugs penetrate the tissues with difficulty. Tyrothricin does not penetrate tissue at all and is of use only against surface infections; so it is useless in cases of chronic infection. Though penicillin and streptomycin may control the chronic infection temporarily, recurrence frequently follows their withdrawal. Penicillin is not inhibited by organic matter, as is the action of the sulfonamide compounds, but it cannot penetrate collections of pus. Streptomycin loses some activity in the presence of body fluids. It is less toxic than the sulfonamide compounds but more toxic than penicillin, and among its more serious effects are toxic involvement of the vestibular and cochlear nerves, allergic-like reactions of skin and joints and certain renal effects.

During the operative period, antibiotics, used locally and systemically, have prophylactic value in preventing complications, and during the postoperative period they limit the spread of infection and tend to shorten the healing period.

The ears and the sinuses are the most frequent sites of primary foci of infection in meningitis. A combination of antibiotic and sulfonamide therapy plus eradication of the primary focus appears to give the most consistent permanent results. This is the wisest course in spite of the fact that frequently initial attacks of meningitis may be controlled by chemotherapy without surgical drainage. Even though osteomyelitis may be controlled by antibiotic therapy, healing occurs only after all necrotic bone has been removed.

M. V. Miller, Philadelphia.

Diagnosis and Treatment of Sinusitis. Marcos Cohen B., Rev. de otorrinolaring. **6**:149 (Dec.) 1946.

Basing his observation on a series of 150 cases of acute and chronic sinusitis, Cohen attempts to evaluate present day concepts of the problems that arise. He reviews the symptoms, the diagnosis and the treatment of the various types of sinusitis. Two important conditions are stressed: (1) suppurative maxillary sinusitis, which may be present even though there is no evidence of a purulent discharge in the middle meatus, and (2) the so-called primary neuralgias of the ophthalmic and the superior maxillary nerves. The author believes that these neuralgias are directly due to pathologic conditions developing in the posterior series of the sinuses, i. e., the posterior ethmoid and sphenoid sinuses.

The diagnosis is comparatively simple when a careful history is taken and a thorough physical examination is made, with the added use of transillumination, nasopharyngoscopy and antroscopy, and roentgen examination.

Cohen stresses the importance of conservative medical treatment and uses surgical methods only after conservative medical treatment has been given a thorough trial and has failed to produce satisfactory results. Either a sulfonamide compound or penicillin was used in the acute cases. The drug was administered either parenterally or orally. Local application of either drug did not show any real value. The author usually supplements intensive sulfonamide therapy with protein therapy.

When surgical intervention is indicated, Cohen employs the Caldwell-Luc operation for maxillary sinusitis, the intranasal operation for ethmoiditis and Riedel's technic for frontal sinusitis. For pansinusitis he employs de Lima's technic, and for simple sphenoiditis he prefers Segura's transseptal approach. He supplements surgical treatment with postoperative chemotherapy in all cases.

PERSKY, Philadelphia.

Miscellaneous

NOTES ON THE PATHOLOGY OF CRANIAL TUMORS: I. OSTEOMAS OF THE SKULL, WITH INCIDENTAL MENTION OF THEIR OCCURRENCE IN THE ANCIENT INCAS. KENNETH H. ABBOTT and CYRIL B. COURVILLE, Bull. Los Angeles Neurol. Soc. **10**:19 (March-June) 1945.

Abbott and Courville report on osteoma of the skull, which is probably the most common of all new growths involving the cranium. However, osteoma is relatively rare, especially if sufficiently large to necessitate surgical attention. Tumors of this type have been recognized since the time of Galen. It is stated that the incidence in the larger neurosurgical clinics is approximately 1 per cent.

The specimens are classified into four types: (1) circumscribed osteoma of the cranial vault; (2) diffuse osteoma, arising most commonly from the sphenoid or the temporal bone; (3) osteoma of the orbitoethmoidal or orbitomaxillary region, and (4) osteochondroma of the cranial floor.

Specimens of the circumscribed osteoma of the cranial vault may be subdivided into (1) the small and usually subclinical osteoma eburneum, which arises by a broad base with either an indistinct or a sharply circumscribed border, and (2) osteoma spongiosum, which is a larger, more rapidly growing tumor and has a central portion of cancellous bone. The latter tumor sometimes becomes large and pedunculated and requires surgical excision, especially when the inner table of the skull is eroded and some degree of pressure on the underlying structures results in neurologic symptoms.

The diffuse osteoma, arising most commonly from the greater wing of the sphenoid bone, from the petrous portion of the temporal bone or, more rarely, from the orbital roof, is an unusual, slowly growing tumor, the orbital variety of which often produces exophthalmos and casts a dense paraorbital shadow on the roentgenogram. It is usually amenable to surgical excision.

The orbitoethmoidal (or orbitomaxillary) osteoma is said to have its origin in a cartilaginous rest which persists in the line of the frontoethmoidal (or maxilloethmoidal) suture line. It may have a complex localization, invading two or more of the regional cavities (orbit, frontal or ethmoid sinus, or cranial chamber), or may be confined within a single cavity, growing eccentrically from a well defined focus. Within such a cavity, the osteoma may become completely detached from its pedicle, an event resulting in the formation of a "dead osteoma," which is biologically inert.

Osteochondroma arising from the cranial floor is an extremely rare growth, but, because it extends upward into the intracranial space, it is to be classified as one of the many possible tumors which may compromise the intracranial space.

The available facts regarding the location and development of the various types suggest that osteoma is the result of some perversion of the union of the suture lines, possibly with formation of isolated cell rests of osseous or cartilaginous character.

GUTTMAN, Philadelphia. [ARCH. NEUROL. & PSYCHIAT.]

STUDIES ON ORAL PENICILLIN. JOHN S. GORDON, Laryngoscope **57**:202 (March) 1947.

Gordon studied the effect of orally administered penicillin in diseases of the ears, nose and throat. Blood serum levels were determined, and the sensitivity of the offending organism also was determined. Fifty thousand units was given every two to three hours. Such doses gave blood levels eight to ten times higher than the threshold of sensitivity of the pathogenic organisms found. In children 25,000 units sufficed. A satisfactory therapeutic effect resulted. Several untoward reactions were encountered.

HITSCHLER, Philadelphia.

INTELLIGIBILITY RELATED TO ROUTINIZED MESSAGES. HENRY M. MOSER, Speech Monogr. **13**:47, 1946.

Even in 1943 the four voice messages uttered over the interphone system of the multiplace airplane were almost completely unsystematized. Since it had been shown that systematic procedures and routinized messages increased intelligibility, the voice communication laboratory at Waco, Texas, was presented with the problem of developing a routinized procedure. The first step was to find the topics, wordings and relative efficiency of current interphone practices. Nearly 2,500 transmissions were recorded. Analysis showed these to relate to over 200 topics of business. Of the 1,500 messages that elicited a verbal response from a listener, 40 per cent of the responses were asking in one wording or another that the original transmission be repeated. The second step was to treat with the order and the words of the routines that necessarily surrounded the messages. The following summary sequence accommodated these requirements: X alerts Y for a message; Y signals readiness for message; X sends and ends message; Y acknowledges message. Experiments were conducted in which alternative wordings and orders of messages were tried. Obviously, understandability can be improved by the routine use of single purpose words. Therefore, different name words, for the most part ones already in use, were tried out for each position in the manner described. For example, the names that were tried for one station were "ball turret," "ball turret gunner," "belly gun" and "ball gun." The third step in the formulation of the procedure was to select words for the message. The method was to study the job analysis recordings for potential topics. For example, a multiplicity of terms was in common use the sense of which was to ask for repetition of a message. Half of them were on the order of "what," "what did you say" and "huh." Others conformed to current or outmoded radiotelephone phrases, and the remainder were bizarre, such as "Put your teeth in, so I can hear you." Finally, devices were borrowed to improve intelligibility through the manner in which words were presented.

PALMER, Wichita, Kan.

INTELLIGIBILITY RELATED TO ARTICULATION. GAYLAND L. DRAEGERT, Speech Monogr. **13**:50, 1946.

Four experiments, three of which were preliminary, were designed to investigate the effects of training of pronunciation or articulation. Thirty-seven student pilots were tested and trained for one class hour in clear pronunciation of words, and retested. Thirty-eight other students were used as a control group. Training given in articulation covered one fifty-five minute class period on the day between the initial and the final test. The training hour included: instruction as to the need of clear articulation; presentation of words containing sounds of low intelligibility; drilling in noise with lists of low intelligibility; demonstration recording "articulation"; drilling with interphone messages in noise. The control group showed no gain, while the experimental group gained about 6.1 points with difficult words. Results show that training for good articulatory patterns is likely to improve intelligibility and is superior to training which attempts to improve the pronunciation of "difficult" sounds only.

PALMER, Wichita, Kan.

UNDERSTANDABILITY OF SPEECH IN NOISE AS AFFECTED BY REGION OF ORIGIN OF SPEAKER AND LISTENER. HARRY M. MASON, Speech Monogr. **13**:54, 1946.

Speakers from the various Service Commands of the United States Army were identified, and intelligibility tests for 1,913 men were analyzed. In making these tests of differential intelligibility, only speakers who were heard by listeners from both regions in question were considered. The various Service Commands had significant differences between them in intelligibility for both speakers and listeners. Real differences in speaking ability for areas are likely but not definitely proved. The Fourth and Sixth Service Commands averaged high in speaking ability; the Eighth, low. The Sixth Service Command furnished outstandingly good listeners. Educational factors, perhaps accounting for some of these differences, should have been minimized, since only familiar one syllable and two syllable words were used in tests, and misspelling was not considered an error. The presumption is that if more precisely defined speech regions formed the basis for analysis instead of Service Commands, greater differential understandability would be discovered.

PALMER, Wichita, Kan.

Book Reviews

Lehrbuch für Hals-Nasen-Ohren-und Mundkrankheiten. By A. Barraud, Lausanne; F. R. Nager, Zurich; L. Rüedi, Bern; E. Schlittler, Samaden, and J. P. Taillens, Lausanne, Switzerland. Price, 60 Swiss francs. Basel, Switzerland: S. Karger, Ltd., 1947.

This is a well written textbook about the ear, nose, throat and mouth. The German in it is concise and easy to read and practically translates itself to one already versed in otolaryngologic terminology.

The many illustrations and colored plates are beautifully done, giving a real life image of the usual and the unusual conditions of the ear, nose, throat and mouth.

Extreme detail has been omitted in the descriptions of many of the radical operations—for example, frontal sinusotomy—and rightly so, since the book is obviously not meant for the expert otolaryngologist, nor even for the serious postgraduate student. Also, it lacks a complete written and visual description of bronchoscopy and eosophagology such as is given generally in so many American books and in particular in that of Jackson and Jackson on otolaryngology.

There is a fine allotment of space for the more frequent diseases, with less space for the infrequent ones, giving a fairly well balanced reference book for the medical student and the general practitioner versed in the German language and continental nomenclature. It is completely modern and up to date in its theoretic considerations and its therapy and hence is of distinct value as a forward step in the rapidly changing panorama of otolaryngology.

Textbook of the Ear, Nose and Throat. By Francis L. Lederer, M.D., and Abraham R. Hollender, M.D. Pp. 579. Price, $7.

This text has some superior plates and illustrations. It should prove a boon to the harried instructor and the confused student. Of course, one must remember, that it is on an undergraduate level; it has no place at all in graduate study. Indeed, it gives only the merest suggestion of otolaryngologic importance and depth.

However, to a busy student of medicine, surgery and obstetrics, it can and will implement the few concise lectures which are allowed for the study of ear, nose and throat.

There is an orderly and thoroughly satisfactory classification of the main conditions as they are seen in otolaryngologic practice. The reading is easy and uninvolved. Each chapter is preceded by a small inclusive review, giving the highlights of its contents.

Operative procedures are described rather vaguely, and many are left out completely. Bronchoscopy is handled lightly, but these things are as they should be in a minor textbook for undergraduate students.

In general, it might be said that this volume is a worth while addition to a medical student's library.

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